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Effect of sowing substrate on coverage and rate of weeding of directly sown annual flower beds

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Abstract

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The method of establishing directly sown annual flower beds has its benefits as well as problems. One of them is particularly surface weeding before sowing. The aim of the experiment was to find a solution to this problem, i.e. whether covering sowing substrates can suppress the germination and growth of weeds and improve growth parameters of annuals. The certified seed mixture of annuals and three variants of substrates that differed in ability to retain water were chosen for the experiment. Substrate A contained 70% vol. of sand and 30% vol. of peat; substrate B 50% vol. of sand, 20% vol. of siliceous marlite, 30% vol. of peat; and substrate C 30% vol. of sand, 40% vol. of siliceous marlite, 30% vol. of peat. In the control variant annuals were sown directly into the soil. The experiment was established in two different sites. Development of the mixture was monitored and evaluated all the season; the coverage with annuals and weed, the height of annuals and flowering time were evaluated. According to the results the use of sowing substrates ensured the successful development of mixtures of annuals, particularly in the initial stand development.

Keywords: annuals; ornamental gardening; landscape architecture; sowing *in situ*; greenery; maintenance

Directly sown annual flower beds are an alternative form of the traditional flower bed of precultivated seedlings. They are used in different functional types of greenery (Nagase, Dunnett 2013). The merits of their application are based on several impulses: trying to reduce the financial and time demands for the establishment and subsequent care of greenery areas in cities; improving environmental conditions in cities; increasing biodiversity (Gaston et al. 2004; Thompson 2004; Duthweiler 2010). This technology of establishing stands of annuals requires little care and assumes the elimination of irrigation.

When establishing directly sown annual flower beds, there is a problem with weed infestation of a plot (Eppel-Hotz 2007, 2008; Dunnett, Hitchmough 2004). There is not satisfactorily resolved maintaining the bed surface without weeds from sowing the mixture of annuals until the time when weeds in closed stand are not able to enforce them-

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selves. The seeds of rapidly evolving annual weeds which are in the flower bed soil prior to its establishment are the most problematic. Their excessive occurrence in the vegetation layer, which in case of annuals represents the thickness from 5 to 10 cm, can partially or completely affect the ability of annual seeds germination and development of the whole mixture. To eliminate the germination of weed seeds we can use the covering sowing mineral substrates based on sand (Hitchmough et al. 2004; Hitchmough, Fleur 2006). The aim of the vegetation experiment was to verify the covering sowing substrates with a thickness of 5 cm with different proportions of sand and to assess their impact on the incidence of weeds, stand coverage, reached height of the mixture of annuals and the time of its flowering, as important parameters affecting the quality of the flower bed.

MATERIAL AND METHODS

For the vegetation experiment three variants of sowing substrates were prepared. The main component of the substrate A was sand with a grain size of 0–4 mm, the main grain proportion (87%) was up to 2 mm with the value pH_{CaCl_2} = 6.5 supplemented with black peat with the value pH_{CaCl_2} = 4.2. Substrates B and C were supplemented with graded doses of 20%, respectively 40% vol. of finely ground siliceous marlite (fraction 0–4 mm) with adequately reduced proportion of sand. Siliceous marlite is a sedimentary rock consisting of siliceous sponges spicules, which contains > 50% of SiO_2, > 40% of clay minerals and < 5% of CaO. Siliceous marlite has high volume water absorption (the 24 h soak test, EN 1097-6:2013), in the range of 36–42% vol. Cation exchange capacity of siliceous marlite is 10–15 $mmol^+/100$ g (ISO 13536:1995). Marlite has lightly alkaline reaction. The pH_{CaCl_2} value of used component was 7.3.

All substrates were supplied with 56 mg of N, 28 mg of P and 75 mg of K per litre of the mixture using fertilizers PG mix (14% N, 16% P_2O_5, 18% K_2O, 0.7% MgO) and potassium sulphate (50% K_2O). For the substrate A without siliceous marlite dolomitic limestone at a dose of 1.5 kg/m^3 to adjust the pH value was used.

The content of available nutrients in mineral substrates and soil in individual experimental sites was determined by the method of Mehlich III (Mehlich 1984), pH_{CaCl_2} value by the method ISO 10390:2005. From the physical properties bulk density and field moisture capacity (water content at potential of –10 kPa, ISO 11274:1998) were determined. The soil in Lednice had sufficient, and the soil in Průhonice high content of available nutrients. The substrates have a relatively low content of available P, K and Mg. The addition of siliceous marlite increased pH value, content of available Ca and field moisture capacity of the mixtures, i.e. the availability of water to the plants (Table 1).

The experiment was established simultaneously at two sites, in the area of the Faculty of Horticulture of Mendel University in Brno, in the campus in Lednice in South Moravia (48°79'N 16°80'E, 174 m a.s.l.); and in the area of Dendrological garden of Silva Tarouca Research Institute for Landscape and Ornamental Gardening in Průhonice in Central Bohemia (50°00'N 14°56'E, 312 m a.s.l.).

In both locations areas at full sun, with a high number of seeds of annual weeds were selected. Plots for sowing were prepared in the same manner – autumn ploughing, loosening the soil to the

Table 1. Physical and chemical properties of substrates and soil of experimental plots

Sample	BD (g/l)	FMC (% vol.)	pH_{CaCl_2}	Available nutrients (mg/kg in dry sample)			
				P	K	Mg	Ca
Substrate A	1,242	13.4	6.2	15	63	81	1,015
Substrate B	1,076	19.3	7.0	5	129	107	11,599
Substrate C	957	27.0	7.1	5	170	146	15,292
Soil Průhonice	1,157	37.5	6.8	229	404	319	4,277
Soil Lednice	1,147	36.6	7.6	55	247	401	10,326
Optimum	–	–	6.3–6.7	51–90	161–250	131–170	2,001–3,300

optimum – sufficient content of available nutrients for medium sandy loam soil; BD – bulk density of dry sample; FMC – field moisture capacity (ISO 11274); pH_{CaCl_2} value (ISO 10390) and content of available nutrients (Mehlich III)

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depth of 15 cm with a rotary cultivator and levelling the bed with reciprocating harrow in the spring. In Lednice maize (*Zea mays*) was grown for two vegetative periods before the experiment. The plot was ploughed to eliminate perennial weeds twice per year (spring, autumn). At the experimental area in Průhonice there was a woody ornamentals nursery till spring 2014. After lifting the plants green manure crop *Phacelia tanacetifolia* was used twice during the vegetative period. Because of growing woody ornamentals there was occurrence of perennial weeds on the plot during the experiment. But the occurrence of annual weeds was dominant.

The areas were divided into experimental plots measuring 2 × 2 meters. Three variants were covered with covering sowing substrates A, B, and C with the thickness of 5 cm; in the fourth control variant D, the sowing was made directly on the soil. The variants were identified by a combination of the letter of substrate variant and location (L – Lednice, P – Průhonice). There were three repetitions in each variant; the experiment was made in a randomized block in each location.

In the experiment the mixture Strakonická louka® compiled at the Faculty of Horticulture of Mendel University in Brno was used. The mixture is commercially produced in the Czech Republic. It contains 16 species of annuals: *Calendula officinalis*, *Eschscholtzia californica*, *Centaurea cyanus*, *Clarkia unguiculata*, *Linaria maroccana*, *Salvia horminum*, all in a mixture of varieties; and varieties of *Gypsophila elegan*s 'Bílý', *Chrysanthemum paludosum*, *Linum grandiflorum* 'Rubrum', *Zinnia haageana* 'Persian Carpet', *Zinnia elegans* 'Liliput směs', *Zinnia elegans* 'Dahlia mix', *Papaver rhoeas* 'Shirley single mixed', *Sanvitalia procumbens*, *Cosmos bipinnatus*, *Tagetes tenuifolia* 'Lulu'.

Sowings were carried out in terms that were climatically suitable for the region and that were allowed by weather in the given year. In Lednice the sowing was carried out on April 22, 2015; in Průhonice, due to colder weather conditions, on May 11, 2015. The term of sowing for each locality was chosen so that the germination would start after the cold period with late ground frosts which often occur in the beginning of May in the Czech Republic. In the second half of May the temperature ranges from 10°C to 15°C, which is optimum for germination of spring annuals sown in the open (Phillips, Rix 1999). The sowing rate was 2 g/m^2. Germination occurred in Lednice in the middle of May, in Průhonice in early June.

Due to extreme climatic conditions in the year 2015 it was necessary to irrigate the experimental areas in both locations at the time germination of annuals (in Lednice May 15; in Průhonice June 5) and during the growing season in order to prevent drying the stand (in Lednice from June 4 to August 15, once a week, together 11 times; in Průhonice on July 30 and twice in the first half of August); always irrigated with a dose of 2 l/m^2. The course of temperature and precipitation in both locations is shown in the Fig. 1. The period in the summer of 2015 was ranked among the historically significant episodes of drought in the Czech Republic, which caused a strong drying of herb layer (Daňhelka et al. 2015).

The experimental areas in Lednice and Průhonice were used in different ways before the establishment of the experiments. The localities have also different climatic conditions. For comparison of the annual stands and weed coverage at different localities with various terms of sowing the stands were evaluated in the same periods after sowing. The experimental plots were cleared of weeds in the initial stand development: in Lednice in the 6th and 8th week after sowing, in Průhonice in the 3rd and 6th week after sowing. In Lednice weeds in all variants were completely removed within the first weeding; during the second weeding even those that germinated later. The weeding was done subsequently after evaluation of the coverage of weeds and annuals. On the basis of both weeding the number of weeds per m^2 was determined. In Průhonice the control variant was heavily weed infested, therefore the weeding was started earlier. During the first weeding it was difficult to distinguish germinating annuals from weeds in the control variant, and therefore weeds were not completely removed. During the second weeding it was not possible to weed the control variant without damaging the annuals; that is why weeds were not removed. The remaining variants were totally weeded. In both locations there occurred species of annual weeds *Echinochloa crus-galli*, *Portulaca oleracea*, *Chenopodium album*; in Lednice *Amaranthus retroflexus*, *Atriplex sp.*; in Průhonice *Fallopia convolvulus*, *Capsella bursa-pastoris* and sporadic occurrence of perennial weeds *Cirsium arvense*, *Convolvulus arvensis*, *Equisetum arvense.*

Evaluating of the stand started in both locations in the 6th week after sowing, in Lednice on June 4; in Průhonice because of the later date of sowing

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Table 2. Scoring of flowering and overall effect of the mixture

Points	Characteristics of flowering and overall effect of the mixture
0	Partially positive – the mixture does not fully fulfil its space-making function; stand is unclosed, does not flower.
1	Partially positive – the mixture partially fulfils its space-making function; blooms of the fastest growing annuals in the mixture appear; the stand is mostly closed.
2	Positive – the mixture is in the optimum development stage and fulfils its space-making function, most annuals are blooming; the stand is height-developed and closed.
3	Positive – stand is height-developed, closed, fulfils its space-making function, there are the first signs of fading away, drying of the mixture (taxa with the fastest development and shortest life cycle).
4	Slightly negative – different species of annuals gradually fade away.
5	Negative – the mixture is already out of blooms, dried; even though residues of flowering plants may still appear, its overall effect is already negative.

on June 24 (i.e. three weeks after the evaluation in Lednice). At 14 day intervals the coverage of annuals and weeds was determined in % of the total experimental area. The coverage was evaluated as projection of the groups of plants when looking at the experimental area from above. At weekly intervals the stand height and flowering and overall effect of the mixture using scoring (Table 2) were evaluated. The stand height was evaluated as the vertical distance from the ground to the point with a majority share of representation of annuals in the stand. The evaluation of the experiment in Lednice ended on September 30, the 23rd week after sowing, in Průhonice on October 7, the 21st week after sowing.

All of the data obtained from the measurements were evaluated statistically by analysis of variance and Duncan's multiple range test (program Unistat 4.53).

RESULTS AND DISCUSSION

Coverage of annuals

During the first assessment in the 6th week after sowing, the highest coverage of annuals (Table 3) within the sites was in the substrate C, var. CP 70%, var. CL 27%. The lowest annual coverage was in control variants DP 55% and DL – only 10%. Even substrates A and B with a high proportion of sand showed themselves positively, as Hitchmough and Fleur (2006) described. All the variants with the covering substrate reached higher coverage of annuals than the control variant without the covering substrate, which was caused by reducing a number of weeds. The effect of the cover layer of the substrate for the initial stand development was significantly positive. Overall lower values of coverage in variants in the locality Lednice were probably caused by an earlier term of sowing, when the effect of lower temperatures and prolonged drought in the initial growth could manifest itself (Fig. 1).

In the 8th week after sowing, differences in coverage of annuals between locations were almost removed, probably due to higher temperatures and the use of irrigation in Lednice. From the 8th week after sowing there was statistically significantly the lowest coverage in the variant DP. In the period between the 12th and the 16th week after sowing there was higher coverage in all variants with the substrates in Lednice, which can be explained by the effect of regular watering.

The coverage of annuals in the control variant DL in Lednice was during this period comparable with variants with substrate. The same variant DP in Průhonice had the lowest coverage. It was caused by less thorough clearing of weeds of control variant in the initial stand development in Průhonice. Between the 18th and the 20th week after sowing, coverage of annuals was balanced in all variants except for variant DP (the influence of heavy weed infestation).

Weed coverage and rate

Before the first weeding in Lednice, the 6th week after sowing (Table 3) the highest weed coverage was observed in control variant DL where no sowing substrate was applied. The application of the covering layer of the substrate was thus confirmed as significant in preventing the germination of annual weeds, thus providing space for development

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Table 3. Coverage of weeds (W) and annuals (A)

Var.	Area coverage in % – week after sowing; measurement date															
week	6.		8.		10.		12.		14.		16.		18.		20.	
Date – L	4. 6.		18. 6.		2. 7.		16. 7.		30.7.		13.8.		27. 8.		10. 9.	
Date – P	24. 6.		9. 7.		23. 7.		6. 8.		20. 8.		9. 9.		17. 9.		30. 9.	
	W	A	W	A	W	A	W	A	W	A	W	A	W	A	W	A
AL	25^{c}	20^{cd}	8^{bc}	70^{ab}	1^{b}	69^{a}	1^{b}	81^{ab}	1^{b}	88 a	1^{b}	92^{ab}	1^{b}	92^{a}	1^{b}	89^{a}
AP	22^{cd}	52^{b}	4^{c}	72^{ab}	3^{b}	74^{a}	3^{b}	64^{b}	4^{b}	68^{b}	5^{b}	80^{c}	4^{b}	90^{a}	3^{b}	90^{a}
BL	13^{cde}	23^{cd}	7^{bc}	70^{ab}	1^{b}	80^{a}	1^{b}	89^{a}	1^{b}	91^{a}	4^{b}	94^{a}	2^{b}	95^{a}	1^{b}	92^{a}
BP	12^{cde}	55^{b}	4^{c}	70^{ab}	2^{b}	72^{a}	3^{b}	69^{b}	3^{b}	69^{b}	4^{b}	83^{bc}	4^{b}	87^{a}	4^{b}	87^{a}
CL	12^{cde}	27^{c}	7^{bc}	73^{ab}	2^{b}	73^{a}	1^{b}	82^{ab}	1^{b}	87^{a}	1^{b}	91^{ab}	1^{b}	88^{a}	1^{b}	88^{a}
CP	7^{e}	70^{a}	2^{c}	81^{a}	1^{b}	83^{a}	1^{b}	74^{ab}	1^{b}	74^{b}	3^{b}	86^{abc}	3^{b}	90^{a}	3^{b}	90^{a}
DL	75^{a}	10^{d}	13^{b}	60^{b}	5^{b}	68^{a}	1^{b}	84^{ab}	2^{b}	94^{a}	2^{b}	96^{a}	3^{b}	93^{a}	3^{b}	91^{a}
DP	43^{b}	55^{b}	63^{a}	35^{c}	82^{a}	10^{b}	82^{a}	10^{c}	82^{a}	10^{c}	72^{a}	23^{d}	78^{a}	15^{b}	78^{a}	15^{b}

Var. – experimental variants; different letters indicate significant differences (Duncan's test, $P < 0.05$); L – Lednice; P – Průhonice

of annuals. The coverage of weeds in control variant in Průhonice was lower than in Lednice due to earlier weeding in the 3rd week after sowing. But it was higher than in variants with sowing substrate.

The intensity and terms of weeding influenced the subsequent development of weed coverage. Throughout the experiment there was high coverage in variant DP that was weeded only once.

The development of weed coverage showed that in areas heavily infested with weeds the thorough weed clearances once or twice in the initial stand development was sufficient. Then the weeds were incapable of growing in the closed stand. The absence of the covering substrate in the control variants showed that the possible removing of weeds might be very difficult as Eppel-Hotz (2007, 2008) described. But if in this case the weeding is not done, the mixture of annuals is suppressed and vegetation element does not function. This was reflected in DP variant in which in the 6th week after sowing weed coverage was 43%, but already in the 10th week after sowing weeds reached coverage of 82%. Thorough, but very labour intensive removing weeds in the control variant DL 75%, where the root system of some annuals could be damaged, demonstrated strong vitality and regenerative capacity of selected annuals. Despite this resolute intervention during the growing, annuals finally matched the coverage of variants with substrates.

In Lednice weeds were completely removed twice. In the control variant DL there was significantly higher number of weeds per m^2 during the first weeding than in the variants with covering substrates (Table 4). The lowest quantity of weeds

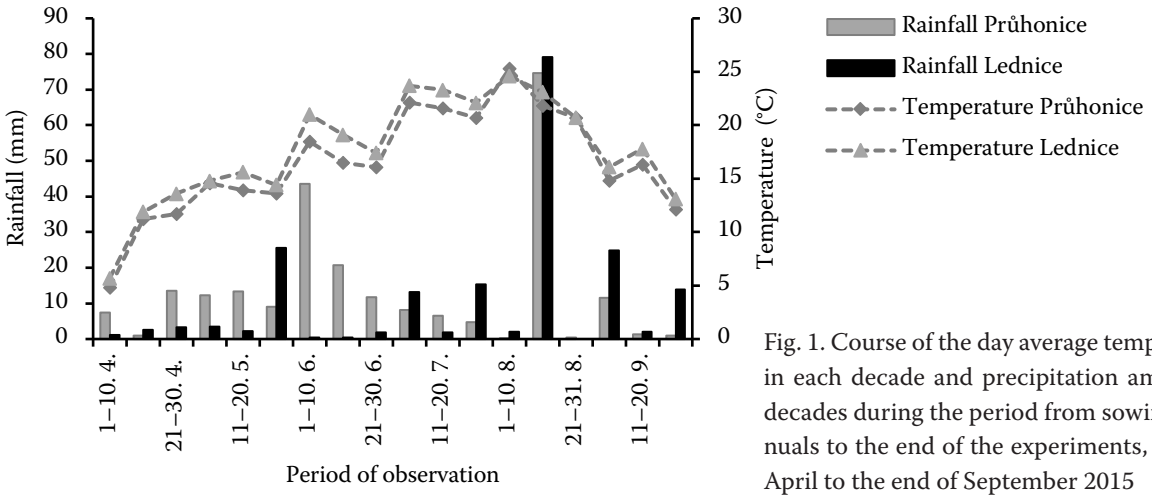

Fig. 1. Course of the day average temperatures in each decade and precipitation amount by decades during the period from sowing of annuals to the end of the experiments, i.e. from April to the end of September 2015

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Table 4. Number of weeds per unit of area – Lednice

Var.	Number of weeds – pcs/m^2		
	1st weeding	2nd weeding	total
AL	173^{b}	32^{a}	205^{b}
BL	179^{b}	22^{a}	201^{b}
CL	112^{c}	19^{a}	130^{c}
DL	648^{a}	37^{a}	685^{a}

Var. – experimental variants; different letters indicate significant differences (Duncan's test, $P < 0.05$)

was recorded in the variant CL. During the second weeding the number of weeds was significantly lower without differences among the variants.

The height of the stand

In the period from the 6th to the 7th week after sowing, the stand in Průhonice was in all variants significantly higher than in Lednice (Table 5). This was caused by faster start of growth due to the later date of sowing. In the 8th week after sowing in Lednice there was significantly lowest height in the control variant DL. This variant was significantly weedy and the growth of annuals was reduced due to the strong competition with weeds and subsequently due to partial damage of the root system during weeding. From the 9th week after sowing the height of stand was the same in identical variants in both locations. Control variants without covering

Table 5. Evaluation of stand height

Var.	Stand height in cm – week after sowing; measurement date; L – Lednice; P – Průhonice									
Week	6	7	8	9	10	11	12	15	18	21
Date – L	4.6	11.6	18.6.	25.6.	2.7.	9.7.	16.7.	6.8.	27.8.	17.9.
Date – P	24.6.	2.7.	9.7.	16.7.	23.7.	30.7.	6.8.	27.8.	17.9.	7.10.
AL	15^{bc}	30^{bcd}	45^{ab}	55^{a}	63^{ab}	65^{a}	69^{a}	72^{ab}	73^{abc}	83^{a}
AP	25^{a}	40^{ab}	46^{ab}	49^{ab}	57^{ab}	57^{ab}	57^{ab}	59^{ab}	78^{a}	80^{ab}
BL	14^{bc}	30^{bcd}	43^{ab}	50^{ab}	60^{ab}	65^{a}	68^{a}	77^{a}	77^{ab}	85^{a}
BP	24^{a}	41^{ab}	49^{ab}	54^{a}	58^{ab}	58^{ab}	58^{ab}	58^{ab}	78^{a}	82^{a}
CL	15^{bc}	27^{cd}	40^{b}	53^{ab}	63^{ab}	68^{a}	70^{a}	73^{a}	75^{abc}	83^{a}
CP	26^{a}	45^{a}	51^{a}	58^{a}	64^{a}	64^{a}	64^{a}	64^{ab}	82^{a}	83^{a}
DL	12^{c}	20^{d}	30^{c}	40^{b}	48^{b}	53^{ab}	58^{ab}	63^{ab}	65^{c}	75^{ab}
DP	20^{bcd}	35^{abc}	41^{b}	47^{ab}	48^{b}	48^{b}	48^{b}	51^{b}	67^{bc}	70^{b}

Var. – experimental variants; different letters indicate significant differences (Duncan's test, $P < 0.05$)

Table 6. Evaluation of flowering and overall effect of the mixture

Var.	Score – week after sowing; measurement date; L – Lednice; P – Průhonice											
Week	6	7	8	9	10	11	12	13	16	17	19	21
Date – L	4.6	11.6	18.6.	25.6.	2.7.	9.7.	16.7.	23.7.	13.8.	20.8.	3.9.	17.9.
Date – P	24.6.	2.7.	9.7.	16.7.	23.7.	30.7.	6.8.	13.8	3.9.	10.9.	24.9.	7.10.
AL	0	0.7	0.7	1.0	1.7	1.7	2.0	2.0	2.7	2.7	2.7	3.0
AP	0	0.7	0.7	1.0	1.7	2.0	2.0	4.0	4.0	3.3	2.7	5.0
BL	0	0.7	0.7	1.0	1.7	1.7	2.0	2.0	2.7	2.7	2.7	3.0
BP	0	1.0	1.0	1.0	2.0	2.0	2.0	4.0	4.0	3.0	3.0	5.0
CL	0	0.7	0.7	1.0	1.7	1.7	2.0	2.0	2.7	2.7	2.7	3.0
CP	0	1.0	1.0	1.0	1.7	2.0	2.0	4.0	4.0	3.0	3.0	5.0
DL	0	0.3	0.7	0.7	1.7	1.7	2.0	2.0	2.7	2.7	2.7	3.0
DP	0	0.0	1.0	1.0	2.0	2.0	2.0	4.0	4.0	3.3	3.3	5.0

Var. – experimental variants

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substrates had generally lower growth compared with variants with substrates in both locations.

Flowering and general effect of the stand

Using the covering substrate accelerated the onset of flowering and therefore also required function by one week in both locations compared to the control (Table 6). In the control variant heavily infested with weeds, especially in DL, the annuals were due to the strong competition of weeds inhibited in the development. The annuals were also partially damaged because of subsequent removal of weeds and thus their growth was slowed, compared with variants with the covering substrates.

In Průhonice in the 7th week after sowing there was the best growth and flowering in substrates B and C with siliceous marlite. Higher moisture capacity of the substrates in comparison with substrate A had a positive impact on initial growth. From the 8th week after sowing the differences in flowering and effect of annuals among variants were removed. Differences between locations became evident in the 13th–17th week after sowing due to different irrigation.

In Průhonice flowering started on July 2, the beginning of full flowering was on July 14. The best flowering (according to the score 2–3) was in Průhonice in the 11th–12th week after sowing (first half of July); then due to the extremely dry weather from mid-July to early August flowers dried. The quality of the stand improved in the17th–19th week after sowing (first three weeks in September), when after the rains the stand was restored. In early October, in the 21st week after sowing, the stand already did not fulfil its function.

In Lednice there was the best flowering (according to the score 2–3) in the 12th–22nd week after sowing (from July 16 to September 24), from August 13 to September 3 the flowering was positively affected by irrigation; in Průhonice in this period the flowers dried.

CONCLUSION

The influence of the covering substrate was already visible in the initial stand development in the 6th week after sowing, when it positively affected the coverage of annuals. All variants with the covering substrate reached a higher coverage of annuals than the control variant without the covering layer. Because of the different terms of sowing there were differences between the localities in the coverage of annuals and needs of weeding. The highest coverage of annuals was reached in both locations with the substrate C (CP 70%, CL 27%), compared to the control variants D where coverage of annuals was in both locations the lowest (DP 55%, DL 10%). From the 8th week after sowing the differences between localities were almost removed, the coverage of annuals in variants with covering substrate was in the range of 70–90%.

In the 6th week after sowing the highest coverage of weeds was in control variants D (DP 43%, DL 75%). The control variant in Průhonice (DP) was not subsequently weeded completely, while in Lednice it was. This led to differences in the development of these variants. In the final stage of development, i.e. 20 weeks after sowing, the coverage of weeds in Lednice in variant DL was only 3% and the coverage of annuals 91%. In Průhonice these values in variant DP were 78%, respectively 15%. The coverage of weeds in variants with covering substrates was at this time very low, up to 3 %. In Lednice the quantity of weeds was evaluated during weeding. It was the lowest in the variant CL 130 pcs/m², the highest in the control variant DL 685 pcs/m².

The covering substrates confirmed their effectiveness in a significant suppression of germination of annual weeds, and easier weeding. Using the covering substrate accelerated the onset of flowering by one week in both locations compared to the control variant and the stand of annuals fulfilled its function a week earlier. In Průhonice the best start of growth and flowering was in substrates B and C with siliceous marlite, where higher moisture capacity of the substrate had positive impact on the initial growth. For weed control the sand substrate A with lower moisture capacity was sufficiently effective.

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