www.nsseme.com/journal.html

Seed Science / Semenarstvo

Ratar. Povrt. / Field Veg. Crop Res. 48 (2011) 397-402
original research article / originalni naučni rad

Sunflower Seedlings Dry Matter Content as Affected by Chemical Treatment and Storage Length

Jelena Mrđa • Goran Jokić • Siniša Prole • Velimir Radić • Vasa Stojšin • Vladimir Miklič

received / primljeno: 01.04.2011. accepted / prihvaćeno: 30.05.2011.

Summary: Chemical treatment of seed is a common crop protection measure. In the case of sunflower seed, fungicides are used regularly and insecticides at an increasing rate. In some cases, sunflower hybrid seed not planted in the first year is planted in the second or even third year after production. Seed vigour decreases gradually over time, which negatively affects seed emergence and subsequent plant growth and development. Seed with high vigour is expected to germinate quickly, producing seedlings that grow fast and uniformly. The objective of this study was to assess the effects of seed chemical treatment and storage length on seedling dry matter content in different sunflower hybrids. The study included several variants with fungicide and pesticide treatments and an untreated control. In the case of the hybrid NS-H-111, highest values of the studied characteristic were recorded in the control and directly after chemical treatment. In the case of the hybrid Sremac, the lowest value was recorded in seed treatment with benomyl+metalaxyl, highest in the treatments directly after chemical treatment and in seed stored for six months. In the case of the hybrid Šumadinac, highest values were recorded in the control and in seed treatment with fludioxonil+metalaxyl, the lowest in seed treatment with fludioxonil+metalaxyl+im idacloprid. Regarding the effect of different seed storage periods, highest values of the studied characteristic were recorded shortly after chemical treatment and in seed stored for six months.
Key words: chemical treatment, length of storage, seedling dry matter content, sunflower seed

Introduction

Considered from the economic and environmental aspects, chemical protection of seed is an effective method of plant protection from diseases and pests in the early stages of development. Seed treatment requires much smaller quantities of fungicides and insecticides than it is the case with foliar or broadcast and strip soil treatments (Marjanović-Jeromela et al. 2008). Seed treatment is a common measure applied to protect seed of field crops. The sunflower hybrid seed not planted in the first year remains to be planted in the second or even the third year after production. However, seed vigour gradually decreases during storage, which adversely affects the germination and subsequent plant growth and development. Seed with high vigour is expected to germinate quickly, and the growth of seedlings is expected to be fast and uniform. According to Vujaković (2001), seed vigour is not a single measurable property, but it combines germinability with seedling growth rate and weight, as well as seedling length (of whole seedling or stem and root separately) (Edwards & Sodler 1992) and seedling dry weight (Anfinrud & Schneiter 1984, Aschermann - Koch et al. 1992). High values of these characteristics indicate that seed has high vigour. Under unfavourable growth conditions, such seed will ensure high and uniform germination as well as a short germination period, which will improve seedling establishment and subsequent development (Vujaković 1997).

The objective of this study was to assess the effect of different chemical treatments and length of storage of seed on the dry matter content of seedlings of different sunflower hybrids.

J. Mrđa (✉) • G. Jokić • S. Prole • V. Radić • V. Stojšin • V. Miklič
Institute of Field and Vegetable Crops, Maksima Gorkog 30, 21000 Novi Sad, Serbia
e-mail: jelena.mrdja@ifvcns.ns.ac.rs

This paper is a part of research on the project TR-31025 „Development of new cultivars and improvement of production technology of oil crops for various uses“ funded by the Ministry of Science and Technological Development, Republic of Serbia. / Ovaj rad predstavlja deo istraživanja na projektu TR-31025 „Razvoj novih sorti i poboljšanje tehnologije proizvodnje uljanih biljnih vrsta za različite namene“ koji finansira Ministarstvo za nauku i tehnološki razvoj Republike Srbije.

Materials and Methods

The study was conducted under laboratory conditions in 2007 and 2008. Seed of three sunflower hybrids (NS-H-111, Sremac and Šumadinac) developed at Institute of Field and Vegetable Crops, Novi Sad were treated with fungicides (benomyl, metalaxyl and fludioxonil) and insecticides (thiamethoxam and imidacloprid). The study involved the following combinations: control (untreated seed), metalaxyl + benomyl (B+M), fludioxonil + metalaxyl (F+M), fludioxonil + metalaxyl + thiamethoxam (F+M+T) and fludioxonil + metalaxyl + imidacloprid (F+M+I). The chemicals were applied in standard doses, i.e. those recommended by manufacturers. To assess the effect of storage length on seedling dry matter content, seed was kept in storage for commercial seed, under conditions that varied in dependence of weather conditions. Seed was stored in paper bags. Tests were conducted at three-month intervals (directly after chemical treatment, three, six, nine and twelve months after chemical treatment). The first measurements of seedling dry matter content were carried out immediately after seed treatment.

The experiment was established in the laboratory for seed testing of Institute of Field and Vegetable Crops, Novi Sad. Dry matter content was calculated in samples that consisted of 4 x 10 seedlings. The seedlings were obtained by seed germination in sand, at a temperature of 25ºC and relative humidity of 95% (ISTA Rules 2007). After four days testing in sand, ten seedlings were placed in moist filter paper. Filter paper rolls were put in plastic bags to maintain humidity. Measurements were done after six days. The samples were dried to constant weight at 80ºC for 17 hours, and their dry matter content was then measured.

The obtained results were statistically processed by the analysis of variance of two factorial split-plot design (factor C - chemical treatment, factor S - storage length) using a computer statistical program. Significance of the obtained differences was determined by the least significant difference (LSD) test, for significance levels of 1% and 5% (Mead et al. 1996).

Results and Discussion

The obtained effects of chemical treatment on seedling dry matter content measured after the different periods of seed storage are shown in tables 2, 4 and 6.

In the case of the hybrid NS-H-111, the analysis of variance showed that there was a highly significant effect of storage length (p = <.001) on seedling dry matter content (Tab. 1). The effect of chemical treatment was not significant (p = 0.181). The effect of the interaction chemical treatment x storage length was also highly significant (p = <.001).

On average for the hybrid NS-H-111, the obtained results indicated that the highest seedling dry matter content was recorded in the control treatment (0.439 g). That value was significantly higher only in relation to the seed treated with B + M, the difference being 0.030 g.

Concerning the effect of storage length, on average, highly significant seedling dry matter content was recorded for seed tested directly after chemical treatment (0.489 g). Table 2 shows that seedling dry matter content dropped with seed storage length. The characteristic was highly significantly lower in seed samples tested after twelve months of storage than in the samples tested after six and nine months (by 0.042 and 0.069 g, respectively). Reduction in quality of treated sunflower seed caused by storage length had already been reported by Mrđa (2009). Opra (2002) concluded that the initial seed weight affects only the length of seedling establishment period, while the initial seed weight and seedling dry matter content are the only factors that affect the loss of seed weight during germination.

The interaction chemical treatment x storage length showed that the seedling dry matter content in the control was highly significantly higher directly after chemical treatment (0.524 g) compared with the other test dates. In the case of the seed treated with B + M, the seedling dry matter content was highly significant higher after three months (0.358 g) than after six and nine months (lower by 0.080 g in both cases).

Table 1. Analysis of variance for hybrid NS-H-111
Tabela 1. Analiza varijanse za hibrid NS-H-111

Source of variation Izvor varijacije	df	ss	ms	F	p
C	4	0.010164	0.002541	1.87	0.181ns
Residual / Pogreška C	12	0.016346	0.001362	0.97	-
S	4	0.160214	0.040053	28.54	<.001**
CxS	16	0.083854	0.005241	3.73	<.001**
Residual / Pogreška S	60	0.084193	0.001403	-	-
Total	99	0.357005	-	-	-

Table 2. Seedling dry matter content of hybrid NS-H-111 (g)
Tabela 2. Suva masa klijanaca hibrida NS-H-111 (g)

Chemical treatment Hemijski tretman (C)	Length of storage – months after treatment Dužina čuvanja posle tretmana (meseci) (S)					Average Prosek (C)
	0	3	6	9	12	
K	0.524	0.378	0.435	0.433	0.425	0.439
B + M	0.417	0.358	0.438	0.438	0.395	0.409
F + M	0.505	0.415	0.443	0.428	0.363	0.431
F + M + T	0.555	0.375	0.440	0.400	0.358	0.426
F + M + I	0.443	0.430	0.478	0.403	0.345	0.420
Average / Prosek (S)	0.489	0.391	0.447	0.420	0.377	-
	C		S		CxS	
$LSD_{0.05}$	0.025		0.024		0.053	
$LSD_{0.01}$	0.036		0.032		0.070	

K = control (untreated seed) / kontrola (netretirano seme)
B + M = benomyl + metalaxyl / benomil + metalaksil
F + M = fludioxonil + metalaxyl / fludioksonil + metalaksil
F + M + T = fludioxonil + metalaxyl + thiamethoxam / fludioksonil + metalaksil + tiametoksam
F + M + I = fludioxonil + metalaxyl + imidacloprid / fludioksonil + metalaksil + imidakloprid

In the case of the seed treated with F + M, the seedling dry matter content was significantly higher directly after chemical treatment (0.505 g) than after three, nine and twelve months, while it was significantly higher after six months than after twelve months of storage (by 0.80 g). In the case of the seed treated with F + M + T, similarly to the control, the seedling dry matter content directly after chemical treatment (0.555 g) was highly significant higher compared with the other variants, and it was highly significant after six months than after twelve months (higher by 0.082 g). In the seed treated with F + M + I, the value of the seedling dry matter content was highly significant lower after twelve months than directly after chemical treatment (lower by 0.098 g), three months (lower by 0.085 g) and six months (lower by 0.133 g), and it was highly significant lower after nine months (0.403 g) than after six months (0.478 g).

The F-test of ANOVA showed that, in the case of the hybrid Sremac, storage length (p = <.001) had a highly significant effect on seedling dry matter content (Tab. 3). The effect of chemical treatment was significant (p = 0.027). The effect of the interaction chemical treatment x storage length (p = <.001) was highly significant.

The results in table 4 for the hybrid Sremac show that on average the seedling dry matter content for seed treated with B + M (0.276 g) was significantly lower than those for seed treated with F + M (0.046 g) and F + M + T (0.050 g), and highly significantly lower than that for seed treated with F + M + I (0.061 g). These results are similar to those reported by Mrđa et al. (2009). Conversely, the results of Inđić et al. (2008), who examined the sensitivity of hulless oil pumpkin genotypes to insecticides used for seed treatment, indicated that an imidacloprid-based insecticide in the amounts of 1-8 ml/kg of seed significantly reduced root dry matter content in the genotype 24.

Concerning the storage lengths examined in this study, the average seedling dry matter content directly after chemical treatment (0.365 g) and after six months (0.353 g) was highly significantly higher compared with the values obtained after three, nine and twelve months, while the value obtained after nine months (0.310 g) was highly significantly higher then after three and twelve months (0.278 and 0.258 g, respectively).

Table 3. Analysis of variance for hybrid Sremac
Tabela 3. Analiza varijanse za hibrid Sremac

Source of variation Izvor varijacije	df	ss	ms	F	p
C	4	0.044637	0.011159	4.00	0.027*
Residual / Pogreška C	12	0.033494	0.002791	2.03	-
S	4	0.170527	0.042632	31.05	<.001**
CxS	16	0.105918	0.006620	4.82	<.001**
Residual / Pogreška S	60	0.082372	0.001373	-	-
Total	99	0.449666	-	-	-

Table 4. Seedling dry matter content of hybrid Sremac (g)
Tabela 4. Suva masa klijanaca hibrida Sremac (g)

Chemical treatment Hemijski tretman (C)	Length of storage – months after treatment Dužina čuvanja posle tretmana (meseci) (S)					Average Prosek (C)
	0	3	6	9	12	
K	0.317	0.295	0.340	0.298	0.268	0.303
B + M	0.284	0.238	0.318	0.290	0.253	0.276
F + M	0.343	0.265	0.375	0.330	0.298	0.322
F + M + T	0.410	0.335	0.325	0.315	0.243	0.326
F + M + I	0.470	0.258	0.408	0.318	0.230	0.337
Average / Prosek (C)	0.365	0.278	0.353	0.310	0.258	-
	C		S		CxS	
$LSD_{0.05}$	0.036		0.023		0.052	
$LSD_{0.01}$	0.051		0.031		0.070	

K = control (untreated seed) / kontrola (netretirano seme)
B + M = benomyl + metalaxyl / benomil + metalaksil
F + M = fludioxonil + metalaxyl / fludioksonil + metalaksil
F + M + T = fludioxonil + metalaxyl + thiamethoxam / fludioksonil + metalaksil + tiametoksam
F + M + I = fludioxonil + metalaxyl + imidacloprid / fludioksonil + metalaksil + imidakloprid

In the case of the control, the interaction chemical treatment x storage length indicated that the seedling dry matter content for seed tested after six months of storage (0.340 g) was highly significant compared with the seed tested after twelve months of storage (higher by 0.072 g). In the case of the seed treated with B + M, the value for seed tested after three months of storage (0.238 g) was highly significantly lower than that for seed tested after six months (0.318 g). In the case of the seed treated with F + M, the seedling dry matter content for the seed tested after six months of storage (0.375 g) was highly significant compared with the values for the seed tested after three (higher by 0.110 g) and twelve months (higher by 0.077 g), while the seedling dry matter content for the seed tested directly after treatment (0.343 g) was highly significantly higher than the seed tested after three months of storage. In the case of the seed treated with F + M + T, maximum and minimum values of seedling dry matter content were obtained for the seed tested directly after treatment (0.410 g) and the seed tested after twelve months of storage (0.243 g), respectively. These values were highly significant compared with the values obtained in the other variants. In the case of the seed treated with F + M + I, the values obtained directly after treatment (0.470 g) and after six months of storage (0.408 g) were highly significant higher compared with those obtained after three, nine and twelve months, while the value obtained after nine months (0.318 g) was highly significant compared with that obtained after twelve months of storage (higher by 0.088 g).

In the case of the hybrid Šumadinac, the analysis of variance showed that both storage length (p = <.001) and chemical treatment (p = <.001) exhibited a highly significant effect while their interaction exhibited a significant effect (p = <0.014) on the seedling dry matter content (Table 5).

The results in table 6 for the hybrid Šumadinac indicated that the seedling dry matter content on average in the control (0.436 g) and for seed treated with F + M (0.422 g) was highly significantly higher compared with the seed treated with insecticides, whereas for the seed treated with B + M (0.409 g) it was highly significant compared with the seed treated with F + M + I (higher by 0.035 g). Similar conclusions were drawn by Inđić et al. (2008) who examined hulless oil pumpkin genotypes for sensitivity to insecticides used for seed treatment. They found that a thiamethoxam-based preparation in the amount of 12 ml/kg of seed and an imidacloprid-based preparation in the amounts of 1-8 ml/kg of seed significantly reduced the dry matter content of aboveground parts in the two tested genotypes as compared with the control. The same preparations, regardless of treatment dose, significantly reduced root dry weight in the genotype 24.

On average for the hybrid Šumadinac, concerning the storage lengths the seedling dry matter content for seed tested directly after treatment (0.484 g) was highly significant compared with the other test dates, whereas the dry matter content for the seed tested after six months of storage (0.425 g) was highly significantly higher compared with the seed tested after three, nine and twelve months of storage.

In the case of the control, the interaction chemical treatment x storage length showed that the seedling dry matter content for the seed

Table 5. Analysis of variance for hybrid Šumadinac
Tabela 5. Analiza varijanse za hibrid Šumadinac

Source of variation Izvor varijacije	df	ss	ms	F	p
C	4	0.050018	0.012505	14.97	<.001**
Residual / Pogreška C	12	0.010023	0.000835	0.74	-
S	4	0.199951	0.049988	44.32	<.001**
CxS	16	0.039815	0.002488	2.21	0.014*
Residual / Pogreška S	60	0.067668	0.001128	-	-
Total	99	0.369086	-	-	-

Table 6. Seedling dry matter content of hybrid Šumadinac (g)
Tabela 6. Suva masa klijanaca hibrida Šumadinac (g)

Chemical treatment Hemijski tretman (C)	Length of storage – months after treatment Dužina čuvanja posle tretmana (meseci) (S)					Average Prosek (C)
	0	3	6	9	12	
K	0.488	0.410	0.473	0.418	0.390	0.436
B + M	0.470	0.335	0.445	0.378	0.415	0.409
F + M	0.548	0.378	0.423	0.383	0.378	0.422
F + M + T	0.465	0.368	0.400	0.375	0.333	0.388
F + M + I	0.450	0.350	0.385	0.370	0.313	0.374
Average / Prosek (S)	0.484	0.368	0.425	0.385	0.366	-
	C		S		CxS	
$LSD_{0.05}$	0.020		0.021		0.048	
$LSD_{0.01}$	0.028		0.028		0.063	

K = control (untreated seed) / kontrola (netretirano seme)
B + M = benomyl + metalaxyl / benomil + metalaksil
F + M = fludioxonil + metalaxyl / fludioksonil + metalaksil
F + M + T = fludioxonil + metalaxyl + thiamethoxam / fludioksonil + metalaksil + tiametoksam
F + M + I = fludioxonil + metalaxyl + imidacloprid / fludioksonil + metalaksil + imidakloprid

tested directly after treatment (0.488 g) was highly significant compared with the seed tested after three, nine and twelve months of storage. The value for seed tested after six months of storage (0.473 g) was highly significant compared with the seed tested after three and twelve months of storage. In the case of the seed treated with B + M, the seedling dry matter content for the seed tested directly after treatment (0.470 g) and after six months of storage (0.445 g) was significantly higher than the values obtained for the seed tested after three and nine months of storage. The value for the seed tested after one year of storage (0.415 g) was highly significant compared with the seed tested after three months of storage (higher by 0.080 g). The seed samples treated with F + M, F + M + T and F + M + I produced seedlings whose dry matter content directly after treatment (0.548 g, 0.465 g and 0.450 g, respectively), was highly significant compared with the values obtained for the subsequent test dates.

According to Janjatović et al. (1972), dry matter content of seedlings and seed germinability depend on the genotype. This study supported their results. Genotypes may differ genetically in seedling growth rate, which need not be related with their germinability in the field; therefore, comparisons should be made only within the genotype (Perry 1981).

Conclusions

In the case of the hybrid NS-H-111, effects of storage length and the interaction storage length x chemical treatment on seedling dry matter content were highly significant, while the effect of chemical treatment was insignificant. Highest values of the tested characteristic were recorded in the control and for the seed tested directly after treatment.

In the case of the hybrid Sremac, effects of storage length and the interaction storage length x chemical treatment on seedling dry matter content were highly significant, whereas the effect of chemical treatment was significant. The lowest value was recorded for seed treated with B + M. Highest values were recorded for seed

tested directly after chemical treatment, seed tested after six months of storage, and the seeds treated with F + M + I.

In the case of the hybrid Šumadinac, effects of storage length and chemical treatment on seedling dry matter content were highly significant, while their interaction had a significant effect. Highest values of seedling dry matter content were recorded in the control and seed treated with F + M. The lowest value was recorded for seed treated with F + M + I. Concerning the effect of storage length, highest values of seedling dry matter content were recorded for seed tested directly after treatment and that stored for six months.

Based on the obtained results it can be concluded that the storage length tended to reduce seedling dry matter content since all genotypes showed lowest values of the tested characteristic when their seed was planted after twelve months of storage. The hybrids reacted differently to the applied chemicals. The obtained data may be useful for planning seed processing, treatment and storage of different sunflower genotypes.

References

Anfinrud M N, Schneiter A A (1984): Relationship of sunflower germination and vigour tests to field performance. Crop Sci. 24: 341-344

Aschermann-Koch C, Hofmann P, Steiner A M (1992): Presowing treatment for improving seed quality in cereals. Seed Sci. Technol. 20: 435-440

Edwards L M, Sodler J M (1992): Growth vigour of some crop species and cultivars when fall seeded as winter cover in the Atlantic region of Canada. Can. J. Plant Sci. 72: 421-429

Inđić D, Vujaković M, Berenji J, Vuković S, Popov V, Glišić S, Bajčev M (2008): Osetljivost genotipova uljane tikve golice prema insekticidima za tretiranje semena. Zbornik radova, IX Savetovanje o zaštiti bilja, 92-93

International Seed Testing Association (ISTA) (2007): International Rules for Seed Testing

Janjatović B, Andjelić M, Borojević S (1972): Broj i dužina primarnih korenčića kod različitih genotipova pšenice. Sav. Polj. 7-8: 567-573

Marjanović-Jeromela A., Marinković R, Milovac Ž, Miladinović D, Sekulić R, Jasnić S (2008): Ispitivanje sjemenskih kvaliteta sjemena uljane repice (*Brassica napus* L.) tretiranog insekticidima i fungicidima. Glasnik zaštite bilja 4: 13-21

Mead R, Curnow R N, Hasted A M (1996): Statistical methods in agriculture and experimental biology. Chapman & Hall, London, UK

Mrđa J (2009): Vitalnost semena genotipova suncokreta u zavisnosti od hemijskog tretiranja i čuvanja. Magistarska teza, Univerzitet u Novom Sadu, Poljoprivredni fakultet, Novi Sad

Mrđa J, Radić V, Prole S, Jokić G, Ostojić B, Butaš D, Miklič V (2009): Apsolutno suva masa ponika linija suncokreta u zavisnosti od hemijskog tretmana i dužine čuvanja. Sel. Semen. 15: 55-62

Opra B (2002): Uticaj porekla i uslova ispitivanja na klijanje hibridnog semena kukuruza. J. Sci. Agric. Res. 63: 27-49

Perry D A (1981): Handbook of vigour test methods. ISTA. Zurich, Switzerland

Vujaković M (1997): Varijabilnost parametara korenovog sistema kod različitih genotipova pšenice (*Triticum aestivum* L.). Magistarska teza, Univerzitet u Novom Sadu, Poljoprivredni fakultet, Novi Sad

Vujaković M (2001): Uticaj fungicida na vigor i biohemijske procese u toku klijanja semena. Doktorska disertacija, Univerzitet u Novom Sadu, Poljoprivredni fakultet, Novi Sad

Ispitivanje uticaja hemijskog tretiranja i dužine skladištenja semena na suvu masu klijanaca suncokreta

Jelena Mrđa • Goran Jokić • Siniša Prole • Velimir Radić • Vasa Stojšin • Vladimir Miklič

Institut za ratarstvo i povrtarstvo, Maksima Gorkog 30, 21000 Novi Sad, Srbija

Izvod: Hemijski tretman semena je uobičajena mera u zaštiti semena ratarskih biljaka. Kod suncokreta se za tretman semena obavezno koriste fungicidi, a sve češće i insekticidi. Ponekad se seme koje ne ode u promet u godini tretmana pušta u promet naredne, a nekad čak i nakon dve godine. Vigor semena se u toku čuvanja postepeno smanjuje, što se nepovoljno odražava na klijanje, a kasnije i na rastenje i razviće. Od semena sa visokim vigorom može se očekivati da klija brže, a da ponik raste brže i ujednačenije. Cilj rada je bio da se ispita uticaj hemijskih tretmana i dužine čuvanja semena na suvu masu klijanaca hibrida suncokreta. U ispitivanje su bile uključene kombinacije sa fungicidima i insekticidima, kao i kontrola. Kod hibrida NS-H-111 najveće vrednosti ispitivanog parametra zabeležene su u kontrolnoj varijanti i kod početnog ispitivanja, dok je kod hibrida Sremac najmanja vrednost zabeležena je kod semena tretiranog sa B+M, a najveća kod početnog i ispitivanja nakon šest meseci. Suva masa klijanaca hibrida Šumadinac u kontroli i kod semena tretiranog sa F+M bila je najveća, dok je najmanja vrednost zabeležena kod semena tretiranog sa F+M+I. Kod ispitivanih dužina čuvanja najveće vrednosti zabeležene su na početnom i ispitivanju nakon šest meseci.

Ključne reči: dužina čuvanja, hemijski tretman, seme suncokreta, suva masa klijanaca