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DRY MATTER ACCUMULATION AND REMOBILIZATION IN WINTER BARLEY AS AFFECTED BY GENOTYPE AND SOWING DATE

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Knowledge about the effect of genotypic variation and sowing date on dry matter accumulation, remobilization and partitioning in winter barley is important for crop management. Therefore, in field studies, six winter barley genotypes of various origin and maturity groups were studied across four sowing dates. In general, grain yield and dry matter content decreased with delayed sowing, after mid-October, and average grain yield in late October and November sowing was lower 14.2% and 16.9%, respectively, compared to the yield in the optimal sowing date. Among the tested genotypes, high grain yield and dry matter content was obtained from late and medium early barley genotypes. Delayed sowing dates, on average, reduced dry matter remobilization and contribution of vegetative dry matter to grain yield. In years characterized by high spring precipitation, late September and early October sowing of medium early and late barley genotypes enable increased accumulation and remobilization of dry matter and obtainment of high grain yield.

Key words: Barley (*Hordeum vulgare* L.); cultivar; sowing date; dry matter; accumulation; remobilization

INTRODUCTION

After the anthesis in small-grain cereals, grain represents the most active sink tissue for assimilate accumulation. During grain filling period, most of translocated assimilates to grain are provided by current photosynthesis (ARDUINI *et al.*, 2006). Further, a substantial part of grain dry matter (DM) can originate from remobilization of assimilates accumulated until anthesis and deposited temporarily in different vegetative parts of plants (SANTIVERI *et al.*, 2004; DORDAS, 2012). GEBBING *et al.* (1999) concluded that the contribution of pre-anthesis DM to grain weight

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depends of the amount of remobilized DM between anthesis and maturity, and conversion efficiency of the remobilized assimilates into the grain. Contribution of assimilates deposited prior to anthesis varies among different cereal crops (ERICOLI *et al*., 2006; PRŽULJ *et al*., 2014), and it can contribute from 5 to 51% to total grain yield of durum and spelt wheat (ERCOLI *et al*., 2008; KOUTROUBAS *et al*., 2012) and from 4 to 24% to grain yield of spring barley (PRŽULJ and MOMČILOVIĆ, 2001). Variation in DM accumulation and remobilization can be attributed to differences in environmental conditions during the pre and post-anthesis periods (EHDAIE *et al*., 2006), genotypes (PRŽULJ and MOMČILOVIĆ, 2001), soils types (MASSONI *et al*., 2007) and crop management (ARDUINI *et al*., 2006). The role of assimilates accumulated prior to anthesis in grain development is crucial under conditions of severe abiotic stress, since it can decrease the negative influence of unfavorable environmental conditions (TAHIR and NAKATA, 2005). EBADI *et al*. (2007) estimated that, in barley, DM remobilization from shoot to grain was increased by water stress from 36 to 82.5%. Similarly, FANG *et al*. (2010) reported that remobilization of pre-anthesis reserves was increased in wheat due to increased seeding rate and root pruning.

The sowing date and varieties are important management factors for exploiting environment conditions and maximizing winter barley grain yields (TURNER, 2004; KISS *et al*., 2014). Generally, the results form long term trials and commercial agricultural production suggest that the best time for winter barley sowing in Vojvodina province (Pannonian plain) is the first decade of October (PANKOVIĆ and MALEŠEVIĆ, 2005). However, in the Pannonian plain, as result of the late harvest of preceding crops, plant producers are often forced to delay the sowing of winter barley until after the optimal period. In most cases delaying the sowing date after the optimal period can result in changed environmental conditions during grain filling, exposing grain growth and filling to water deficit and high air temperatures (FERRISE *et al*., 2010). Late sown winter cereals are more vulnerable to the negative influence of water deficit and high temperature, mainly due to a poorly developed root system (EHDAIE and WAINES, 2001). Delayed sowing often leads to the shortening the period until anthesis and plants enter the reproductive stage erlier and face a shortage of photosynthetic resources (FOULKES *et al*., 2004). According to EHDAIE and WAINES (2001), the variation in DM content at anthesis in response to sowing date could be related to the duration of period from sowing to anthesis. On the other hand, sowing barley too early can also increase production risks. Earlier sowing enables excessive plant growth, increasing susceptibility for cold injury and elevating risk from diseases and attacks by aphids, potential vectors of barley yellow dwarf virus (PAULITZ and STEFFENSON, 2011).

Since accumulation and remobilization of assimilates accumulated prior anthesis to grain during filling are important for yield formation, knowledge of relationships between grain yield and biomass accumulation is important for the further improvement of crop management. The study's objectives were (1) to examine, under field conditions, the accumulation of dry mater in leaves, stems, spikes and whole plant during the vegetative and grain filling periods, and (2) to study the remobilization and contribution of pre-anthesis assimilates to the grain yield of winter barley genotypes in response to different sowing dates.

MATERIALS AND METHODS

Trial sites and treatments

The experiment was carried out at the experimental field Rimski Šančevi of the Institute of Field and Vegetable Crops, Novi Sad (19°51′ E, 45°20′ N, altitude 84 m) during the 2013/14 growing season. The soil type was a non-carbonate chernozem with 2,89% of humus, 54,72 kg ha^{-1} of NO_3, 20,5 kg ha^{-1} of P_2O_5, and 21,8 kg ha^{-1} of exchangeable K_2O before planting and had a pH of 7.74. Fertilizer mono-ammonium phosphate (12N:48P) was applied before sowing, providing 18 kg ha^{-1} of nitrogen (N) and 72 kg ha^{-1} of phosphorus (P_2O_5). According to results of N-min analysis, in February additional 33 ha^{-1} of N, as ammonium nitrate, were applied. Pests and diseases were prevented or controlled by spraying recommended fungicides and insecticides, and weeds were periodically removed by hand. No artificial irrigation was applied.

Six winter barley genotypes of various origin and maturity groups, were tested in four sowing dates. The experiment was conducted in a randomized block design with three replications. The plots were 1.0 m wide and 5 m long, with 0.1 m spacing between rows. The advanced early maturity experimental lines NS 557 and NS 551 are developed at the Institute of Field and Vegetable Crops, Serbia. The cultivars Sonja and Sonate are medium early with stable grain yield, while the cultivars Cordoba and Graval are late maturity with high tillering capacity. Sowing dates (SD) were 27 September (SD1), 11 October (SD2), 25 October (SD3) and 8 November (SD4). Planting rate was 350 germinable grains per m^2 (recommended rate for field scale production).

Weather conditions

Weather data (precipitation and air temperatures) were obtained from a meteorological station situated at the same location where the trial took place and reported as mean decade data, together with 45 year averages for temperature and precipitation (Figure 1). Favorable temperatures and abundant precipitation in October and November provided rapid emergence and crop development. The 2013/14 winter was quite mild with extreme drought (Figure 1). In contrast to the long term average, higher rainfall and temperatures during the spring of 2014 enabled the intensive plant growth and development. Excessive rainfall and an average temperature accompanied grain development in May. Grain filling period of early sowing date passed under optimal environmental conditions, while the grain filling period of late sowing date occurred under higher temperatures compared to the long term average.

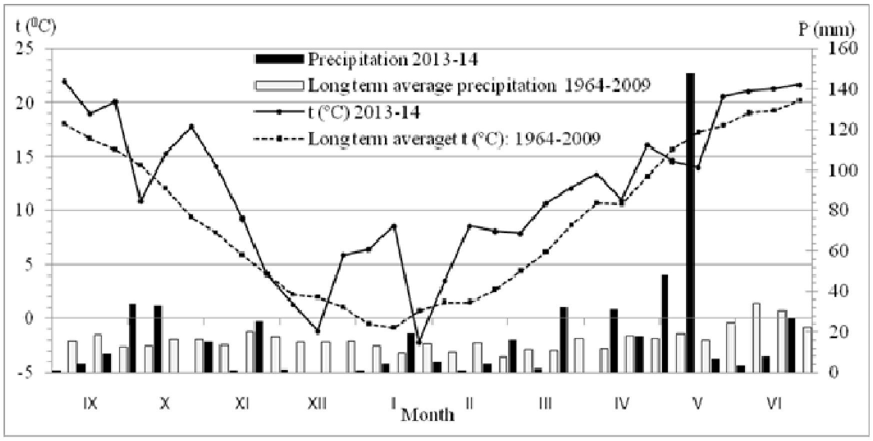

Figure 1. Decade average temperature and precipitation for the 2013/14 growing season and long term average (1964-2009)

Measurements

Measurements of dry matter accumulation were conducted at anthesis (Zadoks 60) and at physiological maturity (Zadoks 90). At both phases a randomly selected 1 m of the central row was harvested at ground level and separated into leaves, stems (including sheaths) and spikes at anthesis, and leaves, stems (including sheaths), chaffs (vegetative parts of spike) and grain at maturity. Samples were dried at 80° C for 48 h before weighing. Dry matter content of above ground plant parts at anthesis (ADM) and physiological maturity (MDM) were recorded. Harvest index (HI) at physiological maturity represented ratio between grain yield and total above ground biomass. The stage of anthesis was estimated to begin when the central florets have shed their pollen and maturity was recorded when peduncle and spike completely lost green color.

Parameters related to DM accumulation and translocation from vegetative parts to grain between anthesis and maturity were calculated according to DORDAS (2012). Dry matter remobilization (DMR) was calculated as the difference between total aboveground DM at anthesis and vegetative plant parts (leaves, stems, sheets and vegetative parts of spike) at maturity (kg ha^{-1}). Dry matter remobilization efficiency (%) (DMRE) was calculated as the ratio of DMR to the DM at anthesis. Contribution of pre-anthesis assimilates to grain (%) (DMRC) was calculated as the ratio of DMR to grain weight at maturity.

Since dry matter loss due to plant respiration was not measured, it was assumed that all of the DM lost from vegetative parts was remobilized to the grain.

Statistical analysis

All statistical analysis were performed using STATISTICA (data analysis software system, version 10 (www.statsoft.com). In order to test the main effect of sowing date (SD), genotype (G) and their interactions (G x SD), data were subjected to ANOVA. Turkey's range test was used to separate the means when ANOVA F-test indicated a significant difference between treatments. Principal component analysis (PCA) was used to determine interdependence between the traits.

RESULTS

Results from our study showed there was a significant influence ($p<0.01$) of genotype and sowing date on barley grain yield (YLD), DM at anthesis (ADM), DM at maturity (MDM), harvest index (HI), DM remobilization (DMR), DM remobilization efficiency (DMRE) and contribution of pre-anthesis DM to grain yield (DMRC). The interaction genotype by sowing date was highly significant for YLD, ADM, HI and DMRC, significant for DMR, while MDM and DMRE were not affected by interaction (Table 1).

Grain yield significantly decreased in late sowing dates (SD3 and SD4) (Table 2). Average grain yield in SD3 and SD4 was lower 14.2% and 16.9%, respectively, compared to SD2. Total aboveground DM at anthesis averaged across all genotypes was 10.78, 9.16, 8.46 and 7.82 t ha^{-1} in SD1, SD2, SD3 and SD4, respectively. By maturity, total plant DM had increased to 15.07, 14.65, 13.58 and 12.96 t ha^{-1} in SD1, SD2, SD3 and SD4, respectively. The highest value of HI was obtained in SD2.

Table 1. Analysis of variance for grain yield (YLD), dry matter weight of above ground biomass at anthesis and maturity, harvest index (HI), post-anthesis dry matter remobilization (DMR), dry matter remobilization efficiency (DMRE) and contribution of DM accumulated until anthesis to grain yield (DMRC) as affected by genotype and sowing date

Source of variation	YLD	Dry matter weight of above ground biomass at		HI	DMR	DMRE	DMRC
		anthesis	maturity				
Genotype (G)	**	**	**	**	**	**	**
Sowing date (SD)	**	**	**	*	**	**	**
Interaction G x SD	**	**	n.s.	**	*	n.s.	**

n.s. not significant;* significant at $P < 0.05$; ** significant at $P < 0.01$

Table 2. Grain yield, dry matter weight of above ground biomass at anthesis and maturity as affected by genotype and sowing date

Sowing date	Genotype						Average
	NS 557	NS 551	Sonate	Sonja	Cordoba	Greval	
	Grain yield (t ha^{-1})						
27 Sep	6.84	7.12	5.92	8.43	7.74	8.16	7.37^{a}
11 Oct	6.58	6.82	8.20	8.29	7.86	8.09	7.64^{a}
25 Oct	6.25	6.09	6.28	6.87	6.75	7.10	6.55^{b}
8 Nov	5.56	6.02	6.58	6.66	6.47	6.85	6.35^{b}
Average	6.31^{c}	6.51^{c}	6.75^{bc}	7.56^{a}	7.20^{ab}	7.55^{a}	6.98
	Dry matter weight of above ground biomass at anthesis (t ha^{-1})						
27 Sep	8.30	8.92	10.86	9.85	10.28	12.25	10.08^{a}
11 Oct	7.58	7.39	9.66	9.21	9.15	11.97	9.16^{b}
25 Oct	7.03	6.77	9.10	8.20	8.94	10.75	8.46^{c}
8 Nov	5.75	6.01	7.44	9.00	8.56	10.19	7.82^{d}
Average	7.16^{c}	7.27^{c}	9.26^{b}	9.06^{b}	9.23^{b}	11.29^{a}	8.88
	Dry matter weight of above ground biomass at maturity (t ha^{-1})						
27 Sep	13.65	13.91	14.87	15.41	15.26	17.33	15.07^{a}
11 Oct	12.74	12.42	14.81	15.63	15.32	16.98	14.65^{a}
25 Oct	12.04	11.47	13.19	14.25	15.10	15.41	13.58^{b}
8 Nov	10.89	11.51	12.81	13.58	13.64	15.31	12.96^{c}
Average	12.33^{d}	12.33^{d}	13.92^{c}	14.72^{b}	14.83^{b}	16.26^{a}	14.06

Different letters indicate significant difference at $P<0.05$ level.

Among tested genotypes, the highest YLD, ADM and MDM were obtained from late and medium early barley genotypes. The YLD ranged between 7.20 and 7.55 t ha^{-1} for late, between 6.75 and 7.56 t ha^{-1} for medium early, and between 6.31 and 6.51 t ha^{-1} for early genotypes. On average, medium early (Sonate and Sonja) and late (Cordoba and Greval) barley genotypes had higher grain yield compared to early lines in each sowing date.

Table 3. Post-anthesis dry matter remobilization (DMR), dry matter remobilization efficiency (DMRE), contribution of DM accumulated until anthesis to grain yield (DMRC) and harvest index as affected by genotype and sowing date

Treatments	DMR (t ha^{-1})	DMRE (%)	DMRC (%)	Harvest index (%)
Genotype				
NS 557	1.77^{d}	24.41^{b}	27.81^{b}	51.13^{ab}
NS 551	2.02^{cd}	27.06^{ab}	30.62^{b}	52.89^{a}
Sonate	3.05^{ab}	32.37^{a}	45.81^{a}	48.59^{bc}
Sonja	2.62^{bc}	28.45^{ab}	34.54^{b}	51.28^{ab}
Cordoba	2.30^{cd}	24.49^{b}	31.61^{b}	48.56^{bc}
Greval	3.29^{a}	28.92^{ab}	43.36^{a}	46.38^{c}
Sowing date				
27 Sep	3.22^{a}	31.72^{a}	44.19^{a}	48.98^{b}
11 Oct	2.67^{b}	28.73^{ab}	34.56^{b}	52.30^{a}
25 Oct	2.14^{c}	25.02^{b}	32.64^{b}	48.60^{b}
8 Nov	2.00^{c}	24.99^{b}	31.11^{b}	49.33^{b}

Different letters indicate significant difference at $P<0.05$ level.

The relative contribution of dry matter accumulated until anthesis to barley grain yield significantly varied across SD and G (Table 3). Delayed sowing dates, on average, reduced post-anthesis dry matter remobilization, dry matter remobilization efficiency and contribution of dry matter accumulated until anthesis to grain yield. DMR was greater at sowing dates SD1 and SD2 than in later sowings (SD3 and SD4). Generally, a greater amount of DM accumulated at anthesis enabled increased DMR and DMRE. Further, genotypes responded differently across sowing dates to post anthesis changes in DM movement in plant. The amount of DMR was the lowest in NS 557 followed by NS 551 and Cordoba, and the highest in Greval and Sonate. Thus, grain development of Greval and Sonate relies significantly on remobilization of DM from vegetative plant parts. HI was affected by genotype, and generally, early lines and cultivars had higher HI values.

Dry matter content per genotype across sowing dates in individual plant organs (leaf blades, stems and ears) at anthesis and maturity is shown in Figure 2. Vegetative organs contributed to DM at anthesis and maturity in the order: stem>leaves>spikes/chaffs. There was a significant variation for amount of DM at anthesis accumulated in stem, leaves and spikes among genotypes and SDs (data not shown). Leaves dry matter content of plants at anthesis in SD1 ranged from 2.48 to 3.23 t ha^{-1}, stem DM ranged from 4.56 to 7.04 t ha^{-1} and spike from 1.10 to 1.99 t ha^{-1}. By delaying SD, dry matter of all plant parts reduced almost linearly, both at anthesis and physiological maturity (Figure 2). While the dry matter of all plant parts was reduced due to later sowing, the amount of DM reduction differed between genotypes. The lowest leaf dry matter reduction at anthesis from SD1 to SD4 had the late genotype Greval and highest the medium early genotype Sonate. On the other hand, stem DM reduction was lowest in Sonja and highest in NS 551.

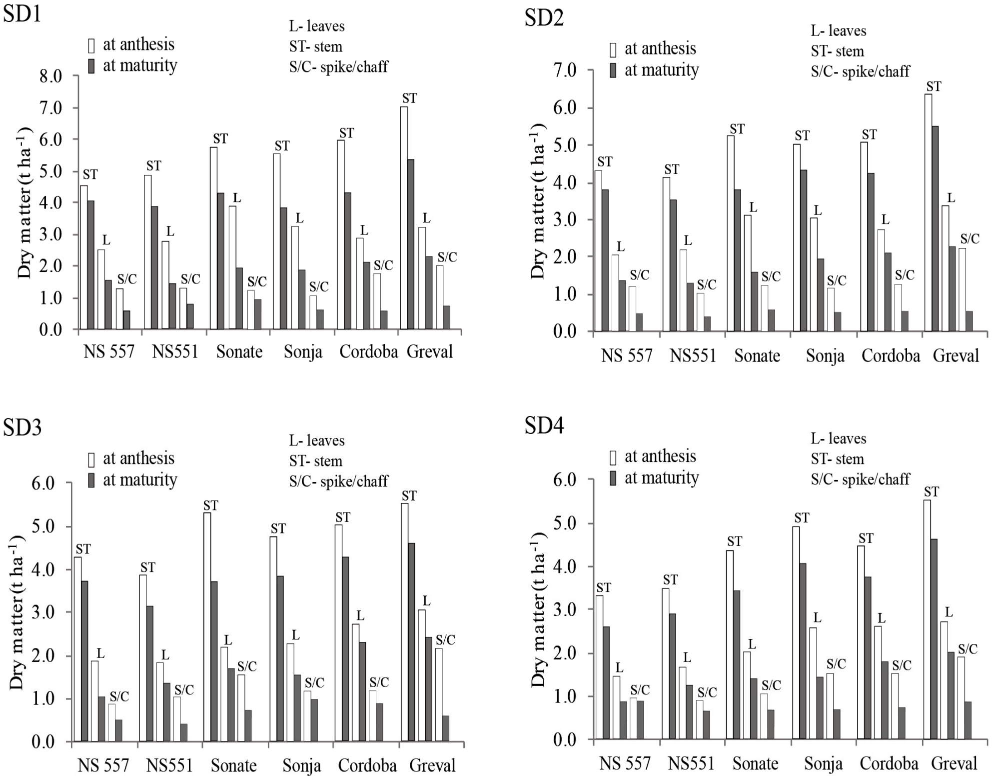

Figure 2. Dry matter content in individual plat organs (stems, leaves and spikes/chaffs) at anthesis and maturity as affected by sowing dates and genotypes

By maturity, dry matter content of all vegetative organs had decreased in all sowing dates, which means that the tested genotypes used DM accumulated until anthesis for grain filling. At maturity, the highest amount of stem DM was recorded in SD1 and ranged from 3.82 t ha^{-1} in Sonja to 5.39 t ha^{-1} in Greval. The lowest stem DM was obtained in in sowing date SD4 and varied from 2.59 t ha^{-1} in the early line NS 557 to 4.65 t ha^{-1} in Greval. Leaves DM ranged from 1.42 (NS 551) to 2.31 t ha^{-1} (Greval) in SD1, and from 0.89 (NS 557) to 2.02 t ha^{-1} (Greval) in SD4.

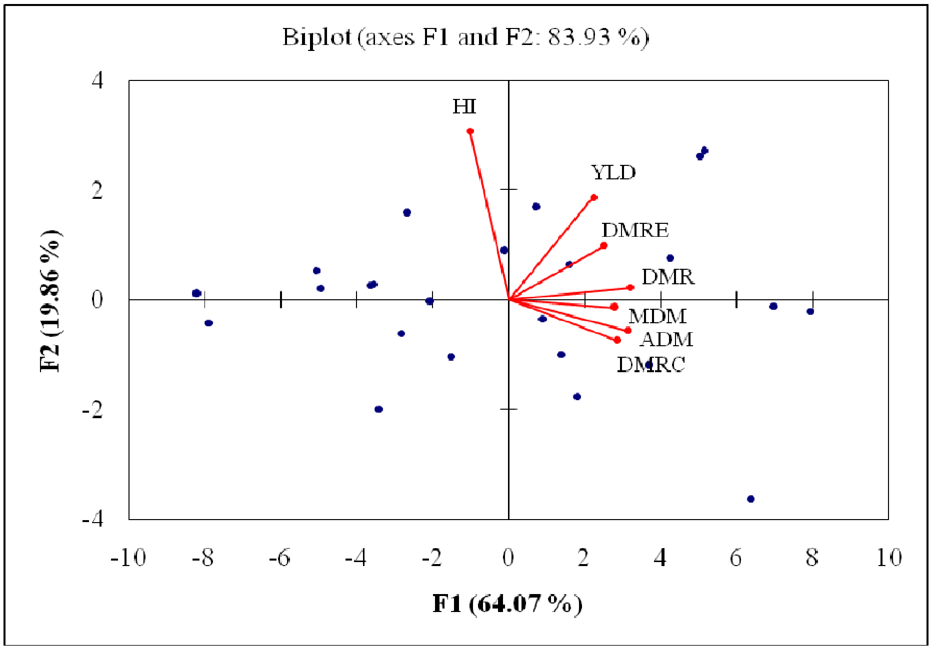

Figure 3. PCA analysis of trait association (harvest index – HI, dry matter at anthesis – ADM, dry matter at maturity – MDM, dry matter remobilization – DMR, dry matter remobilization efficiency – DMRE, contribution of pre-anthesis DM to grain yield – DMRC and grain yield - YLD) in winter barley across four planting dates

In order to investigate the association between YLD, HI and parameters related to DM accumulation and remobilization (ADM, MDM, DMR, DMRE and DMRC) across four SDs, a PCA biplot was constructed (Figure 3). The first PCA explained 64.07% of total variation, while the second PCA explained 19.86%. Together, both axes accounted for 83.93% of the total variation in the data. According to the biplot, PCA1 relates predominantly to MDM and DMR, while HI was mostly related to PCA2. PCA showed that grain yield was positively associated with HI and DM accumulation and remobilization parameters (ADM, MDM, DMR, DMRE and DMRC), as indicated by the acute angles. Further, strong positive association was found between DMRC, ADM, MDM and DMR, as indicated by the acute angle. These traits were negatively correlated with HI. Additionally, DMRE had a weak positive association with HI.

DISCUSSION

In order to understand the physiological basis of dry matter accumulation and contribution of deposited DM until anthesis to the developing grain, six winter barley genotypes had been evaluated across different sowing dates. In Pannonian plain maize is most widespread and common preceding crop for barley production. Often as result of late maize harvest, barley is sown after the optimal period. Therefore it is necessary to understand winter barley cultivar performance across various sowing dates.

Many authors have discussed the importance of the appropriate variety choice for growing in variable environmental conditions (JAĆIMOVIĆ *et al.*, 2013, AĆIN *et al.*, 2013). In our study, the highest dry matter accumulation until anthesis was found in late barley genotype Greval (11.29 t ha^{-1}), possibly a result of better tillering capacity and longer duration of vegetative period. Our results were consistent with reports by SANTIVERI *et al.* (2004) and KOURTUBAS *et al.* (2012), who recorded that in small grain cereals variability in biomass is mainly associated with differences in growth duration. On the other hand, PRŽULJ and MOMČILOVIĆ (2003) reported genetic variability for dry matter accumulation and translocation in spring barley, attributing it to adaptation to specific agroclimatic conditions. Further, results from our study showed that genotypes Greval and Sonate had the highest values of DMR, indicating that accumulated DM prior to anthesis is important for grain development of these genotypes. The low values of DMR and DMRC were recorded in early genotypes, meaning that these genotypes use mainly assimilates formed by photosynthesis during grain filling. We found that DM in vegetative parts declined across all SD and genotypes from anthesis by maturity, suggesting that a significant part of deposited DM was remobilized and utilized for grain filling. Remobilization of DM deposited in vegetative parts is particularly important under unfavorable climatic conditions (ARDUINI *et al.*, 2006; KOUTROUBAS *et al.*, 2012).

Optimal sowing date is one of the most important management factors for maximizing production of high-yielding winter barley varieties (PANKOVIĆ and MALEŠEVIĆ, 2005). Proper sowing date enables the development and growth of healthy and vigorous plants and the achievement of maximum cold tolerance (SCHWARTE *et al.*, 2006). Barley genotypes, sown in SD1, had the highest ADM and MDM. By delaying sowing date, similar trends of progressive reduction of amount of DM accumulated at anthesis and maturity was reported (Table 1). Although average grain yield of winter barley genotypes was decreased due to delayed sowing (Tabele 2), higher level of spring precipitation can reduce negative influence of increased temperature during grain filling period (MCKENZIE *et al.*, 2005), and enabled that medium early and late genotypes achieve higher grain yield in SD3 and SD4, compared to early lines. NOWOROLNIK (2012) reported that late cultivars, characterized by increased tillering and high dry matter accumulation prior anthesis, had lower decrease in grain yield in delayed sowing.

WHITE *et al.* (2011) concluded that sowing date modifies the efficiency of vegetative DM accumulation and remobilization to grain due to the change in duration of the vegetative period and unfavorable environmental conditions during grain filling period and shorter grain filling period. DMR, DMRE and DMRC were also affected by sowing date. Since DMR, DMRE and DMRC were associated with the amount of assimilates accumulated prior to anthesis, later sowing also reduced these traits. Therefore, SD1 sowing enabled more intensive early growth and DM accumulation until anthesis, and generally greater DMR to the growing grains. Further, across genotypes, contribution of pre-anthesis assimilates to grain ranged from 31.11% (SD4) to 44.19% (SD1). The values for contribution of pre-anthesis assimilates to grain recorded in our study were in the same range as results in barley (DORDAS, 2012) and durum wheat (ERCOLI *et al*., 2006), but higher than in spelt and bread wheat (KOUTROUBAS *et al*., 2012). JUSKIW and HELM (2003) reported that in barley late sowing test weight, grain weight and number of tillers per plant were also reduced.

Sowing date had a significant influence on barley HI. As a result of an un-proportional reduction in grain yield and shoot biomass, i.e. total above ground mass, the harvest index in SD3 and SD4 compared to SD2 was reduced for 7.1% and 5.7%, respectively. On the other hand, BASSU *et al*. (2009) stated that in wheat the reduction in shoot biomass and grain yield were proportional, thus the mean harvest index with late and optimum sowing dates were similar. Winter barley sown in SD1 had lower HI values than barley sown in SD2. Lower HI was not a result of decreased grain yield, but of higher plant biomass due earlier sowing.

Grain yield is one of the most important and complex traits, and therefore understanding the association between yield and traits related to DM accumulation and remobilization is important for the increase of productivity and selection of new genotypes. Positive associations were observed between all DM accumulation and remobilization parameters (ADM, MDM, DMR, DMRE and DMRC). In twenty barley genotypes evaluated across four growing seasons, PRŽULJ and MOMČILOVIĆ (2001) also observed positive relationships between these traits. Grain yield was positively associated with all studied DM accumulation and remobilization traits. Our results support the findings of DORDAS (2012), who showed a positive relationship between the amount of accumulated DM until anthesis and grain yield. A relationship between grain yield and dry matter remobilization efficiency was stronger than between other traits, indicating that proportion of retranslocated dry matter accumulated until anthesis plays an important role in barley grain filling. According to Fig. 3, ADM and MDM were negatively associated with HI, i.e. barley cultivars with increased ADM and MDM tended to have reduced HI.

Most of plant DM at anthesis was distributed in the stems, followed by leaves and spikes. Thus, stem has been identified as a major pool for ADM and DMR in winter barley. In recent detailed study, AYNEHBAND *et al*. (2011) reported variation in contribution of different stem parts (peduncle, penultimate and lower internodes) to wheat grain yield. Same authors further noted that the amount of DM at anthesis and maturity in the stem was reduced by delayed sowing dates. The amount of DM reduction varied between different barley genotypes and plant parts (Figure 2). With the delay of sowing from SD1 to SD4, the decrease in DM in leaves was the least pronounced in the late maturity genotype Greval (0.5 t ha^{-1}) and the most pronounced in the medium maturity genotype Sonate (1.87 t ha^{-1}). In the stem, on the other hand, the DM decrease was the lowest in Sonja (0.61 t ha^{-1}) and the highest in the early maturity genotype NS 551 (1.4 t ha^{-1}).

CONCLUSIONS

In conclusion, the highest grain yield was obtained with early barley sowing dates (SD1 and SD2). Delayed sowing dates (SD3 and SD4) resulted in reduced grain yield and MDM, due to reduced ADM, a shorter overall growth cycle and increased temperatures during grain filling period. The barley genotypes differed significantly in grain yield, DM accumulation at anthesis and maturity, harvest index, DMR, DMRE and DMRC. The highest grain yield was recorded with the late and medium early barley genotype. The highest DM at anthesis and maturity was in genotypes Greval and Sonja that showed the highest DMR. It can be concluded that in years characterized by high spring precipitation early sowing of medium early and late barley genotypes enables increased accumulation and remobilization of DM and the achievement of high grain yield.

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AKUMULACIJA I REMOBILIZACIJA SUVE MATERIJE KOD OZIMOG JEČMA U ZAVISNOSTI OD GENOTIPA I ROKA SETVE

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Izvod

Poznavanje uticaja genotipa i roka setve na produkciju suve materije kod ozimog ječma značajno je za pravilnu primenu agrotehničkih mera. U ovom radu prikazana je akumulacija, remobilizacija i raspodela suve materije kod šest genotipova ječma različitog porekla i ranostasnosti (rani, srednje rani i kasni), sejanih u četiri roka setve. Generalno, prinos zrna i sadržaj suve materije smanjio se kod kasnijih rokova setve posle polovine oktobra. U odnosu na optimalan rok setve početkom oktobra, usled setve krajem oktobra prosečan prinos smanjio se za 14,2%, a setvom u novembru za 16,9%. Kod ispitivanih genotipova, kasne i srednje rane sorte su u proseku ostvarile viši prinos zrna u odnosu na rane. Kasna setva smanjila je akumulaciju suve materije do cvetanja, što je dovelo i do smanjenja remobilizacije organske materije akumulirane do cvetanja i njenog doprinosa u formiranje prinosa zrna. Na osnovu datih podataka može se zaključiti da u godinama sa povećanim prolećnim padavinama setva srednje ranih i kasnih sorti ozimog ječma omogućava bolju akumulaciju suve materije, i ostvarivanje viših prinosa zrna.

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