Cruciferae Newsletter

May 2014 – vol. n°33

Acknowledgements

The current issue of the Cruciferae Newsletter (vol. 33) is published online from the Brassica website (http://www.brassica.info/info/publications/cruciferae-newsletter.php). We apologize for being so late to publish this issue. The present issue contains 7 contributions. Members of the editing board would like to acknowledge the authors for the quality of their contributions. For future issues, we would be gratefull if all the authors could read and follow carefully the author recommendations before submitting their manuscript, in order to facilitate the editing process. In particular, it is necessary to mention one of the listed topics that is the most relevant to the presented work (see the list at the end of the present issue).

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In this issue

Author contributions

Section 1: Genetic resources

Section 2: Agronomy and variety trials

A bunchy genotype in Indian mustard (*Brassica juncea*)

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Abstract
A field experiment was carried out to characterize 460 accessions of rapeseed-mustard germplasm. One accession of Indian mustard (IC 355399-A) was observed with bunchy siliquae type, borne in compact clusters. This trait is not reported earlier in Indian mustard. The seeds were grown and selfed continuously to develop pure lines from 2005- 2013 and also evaluated for various agro-morphological traits to compare with national checks. This genotype had more number of siliqua (60-70/ plant) than checks. Further, the genotype also showed superiority over normal varieties for yield related traits such as seed yield and number of primary branches etc. So, this unique germplasm can be utilized in national mustard improvement programme as donor for yield contributing traits.

Key words: Indian mustard, bunchy siliquae, agro-morphological traits

Introduction
The family *Brassicaceae,* is one of the ten most economically important plant families. The Indian sub-continent is an important source of diversity for Brassicas (Prakash and Hinata, 1980). The north-eastern and north-western regions hold promising genetic variability in oleiferous Brassicae. Rapeseed-mustard group comprising of six different species, viz., Indian mustard (*Brassica juncea* (L.) Czern. & Coss.), toria (*B. rapa* L. var. toria*)*, yellow sarson (*B. rapa* L. var. yellow sarson*)*, brown sarson (*B. rapa* L. var. brown sarson*)*, gobhi sarson (*B. napus* L.*),* karan rai (*B. carinata* Braun.) and black mustard (*B. nigra* (L.) Koch.). Indian mustard (*Brassica juncea* (L.) Czern and Coss.) occupies about 90% of total acreage under rapeseed-mustard cultivation in India (Singh, 1996; Singh and Sharma, 2007). In spite of coordinated efforts at national level, productivity of Indian mustard is quite low. One of the reasons for low productivity is the very narrow genetic base of the cultivars. So, there is need of continuous screening of germplasm to identify promising or trait-specific genotypes for use in national crop improvement programme.

Material and Methods
During rabi season, 460 accessions of rapeseed-mustard germplasm were grown in an augmented block design along with three check varieties at NBPGR Experimental farm, New Delhi. In the germplasm, an accession of Indian mustard (IC 355399-A) collected from Fatehagarh district of Uttar Pradesh, medium-tall plants with prolific bearing siliquae borne in compact clusters were observed. Such bunchy genotype in Indian

mustard has not been reported earlier. Therefore, details of the plant were studied along with two check varieties of Indian mustard namely Varuna and Kranti at NBPGR Experimental Farm, New Delhi for two years. Flowers of this plant were bagged and selfed-seeds were harvested. Selfed seeds from bunchy plant were grown during 2005-2013 to develop pure line. Seeds of this bunchy mustard genotype have been supplied to different mustard research centres for evaluation and validation. Plants have been utilized in crossing programmes at Indian Agriculture Research Institute (IARI) New Delhi, Directorate of Rapeseed Mustard Research, Bharatpur (Rajasthan) and S.K. Rajasthan Agriculture University, Agriculture Research Station, Navgaon, Alwar (Rajasthan) for utilization in crop improvement.

Results and Discussion

The mutant plants multiplied from the selfed-seeds, also produced compact inflorescences, with siliquae in clusters. The plants were quite distinct from normal plant population of Indian mustard. It was observed to be a spontaneous mutant with distinct bunchy habit of inflorescence. Flowers as well as siliquae were borne in compact clusters (Fig. 1A & 1B). The bunchy genotype had compact inflorescence type with more number of siliquae (60-70 siliquae/ plant) as well as higher seed yield (8.2 g/ plant) as compared to the check varieties. On an average, bunchy type plants had more number of primary branches than Varuna and Kranti. The details of vegetative and reproductive traits of the genotype as well as two check varieties of Indian mustard have been given in Table 1.

Since there is a narrow genetic base of Indian mustard, the diverse bunchy habit can be useful in widening diversity of Indian mustard. The bunchy genotype showed superiority over normal varieties for yield contributing traits. These plant types can be utilized directly or indirectly for developing high yielding varieties/hybrids. This mustard genotype will be further characterized for identifying marker genes associated with this character which can be a useful material for basic/ academic research to study inheritance in Indian mustard. Because of compact and erect habit of the bunchy plants, there was no pod shattering and lodging of the plants at maturity. Thus, this plant type will be suitable for mechanical harvesting. Seeds of the bunchy genotype have been multiplied and supplied to different breeders for utilization in mustard improvement programme.

Acknowledgements

The authors are grateful to the Director, NBPGR, New Delhi for providing facilities to carry out studies. Thanks are also due to Sh. R.C. Yadav and Dr. Y.S. Rathi Technical Officers for recording data and technical assistance in field work.

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Table 1. Comparative details of important agro-morphological traits of bunchy genotype *vis. a vis.* two check varieties of Indian mustard

S. No.	Character	Bunchy Genotype	Varuna	Kranti
1.	Plant height (cm)	115.2	129.9	134.5
2.	No. of primary branches/ plant	5.2	4.5	4.7
3.	Length of main fruiting branch (cm)	36.5	67.1	44.9
4.	Number of siliquae on main fruiting branch	69	26.8	21.6
5.	Number of seeds per siliqua	14.6	12.8	15.8
6.	Days to mean flowering	74	75	86
7.	Days to mean maturity	133	134	139
8.	Seed yield per plant (g)	8.2	7.2	7.5
9.	1000 seed-weight (g)	4.16	4.40	3.34
10.	Oil content (%)	35.88	36.90	38.15

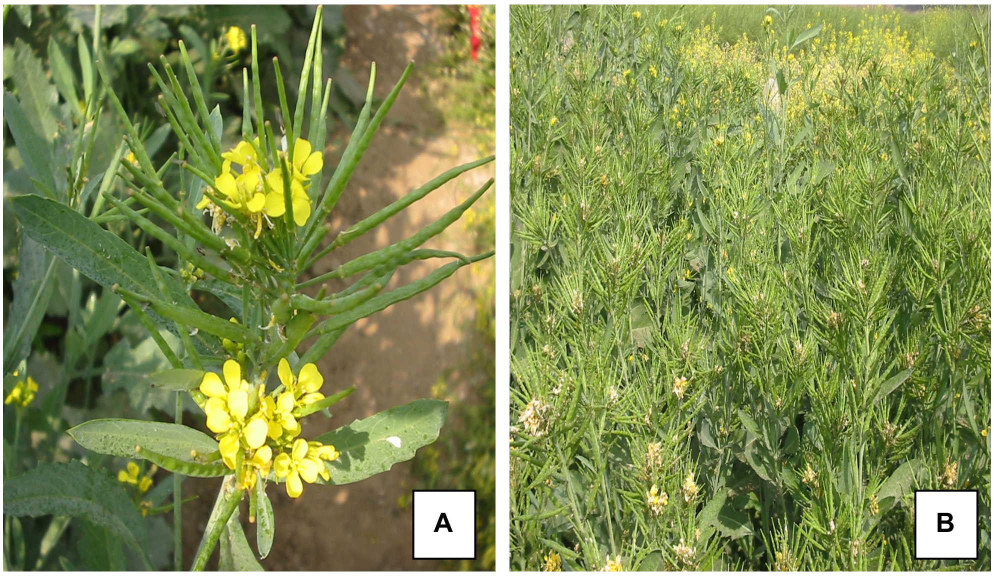

Fig 1. Flowers (A) and siliquae (B) in bunchy genotype of Indian mustard

Gamma rays mutagenesis induced male sterility in rapeseed (*Brassica napus* L.)

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Abstract

Rapeseed hybrid breeding is yet to be established in Pakistan due to the lack of effective measures for development of efficient male sterile lines. Induction of male sterility through mutation breeding can provide an effective mean for hybrid seed production in rapeseed. An attempt was made to induce male sterility through gamma rays mutagenesis in 10 rapeseed genotypes. Higher gamma doses induced more sterility while genotype NR-28/09 was found most sensitive to gamma mutagenesis with highest number of sterile mutant plants.

Introduction

For breeding of hybrid varieties in rapeseed, one of the most important materials is male sterile lines. Rapeseed is largely self-pollinated and androgynous crop and it is difficult to obtain hybrid by emasculation. Therefore, use of male sterile system is the most practical method in the production rapeseed hybrid seeds. Male sterile line could be found in nature or may be induced by mutation. In the present study male sterility was induced in rapeseed genotypes through seeds gamma mutagenesis.

Material and Methods

Five doses of 0, 1.0, 1.2, 1.4, and 1.6 K Gy of “gamma rays” were used to induce male sterility in 10 high yielding and locally adapted rapeseed genotypes.

Results and Discussion

Gamma mutagenesis successfully induced male sterility in rapeseed plants at all levels of irradiation. Induced variability for plant fertility was analyzed through induction of morphological mutations in male parts of flower structure in mutant and normal untreated plant populations. Gamma rays adversely affected the plant fertility in all genotypes that lead to the greater sterility. The highest sterility of 24.50% was induced by gamma mutagenesis in genotype NIFA/NR-2-1/09. Genotypes 04 K 12/13-10-1 and NIFA/NR-23/09 both produced 23.45% sterile plants as compared to 2.12 and 1.77% sterile plants in respective control. The gamma rays reduced the general growth and development of rapeseed plants with increase in irradiation doses. While escalated sterility was observed in higher doses as compared to lesser gamma doses and un-treated rapeseed population.

Based on visual observation, gamma rays dose-wise field screening was exercised for the male sterility in all

M_2 plants of 10 rapeseed genotypes during flowering stage. Total 1516 plants containing or suspected to contain the sterile mutant allele were observed, identified and tagged. Highest number of mutant plants with distorted stamens was observed in genotype NR-28/09. Total 228 mutant plants were isolated with deformed stamens in all genotypes. Total 339 mutant plants with deformed flowers were observed for all 10 genotypes while maximum mutant plants of mutated flowers were registered in genotype NR-28/09. One hundred and thirty two plants with polycarpus flowers were also observed in segregating mutant population. Genotypes NR-21/09 and Punjab Sarsoon produced maximum number of such flowers (16 each). Gamma radiation also affected the whole morphology of rapeseed plants. Genotype NR-28/09 produced maximum number of mutant plants with changed ideotype as compared to rest of the genotypes.

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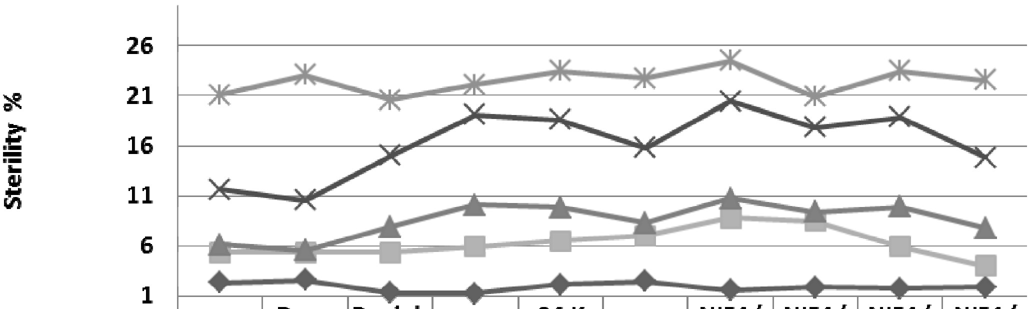

	Abasin-95	Durr-e-NIFA	Punjab Sarsoon	NH 97-5/2-4	04 K 12/13-10-1	Hyola-401	NIFA/NR-2-1/09	NIFA/NR-21/09	NIFA/NR-23/09	NIFA/NR-28/09
Control	2,34	2,59	1,33	1,23	2,12	2,45	1,54	1,89	1,77	1,87
1.0 kgy	5,32	5,32	5,36	5,92	6,48	7,02	8,83	8,50	5,94	4,03
1.2 Kgy	6,13	5,56	7,89	10,07	9,8	8,32	10,75	9,38	9,91	7,79
1.4 Kgy	11,65	10,56	14,99	19,13	18,62	15,81	20,43	17,82	18,83	14,80
1.6 Kgy	21,11	23,06	20,56	22,14	23,45	22,78	24,5	20,88	23,45	22,6

Figure 1. Effect of gamma radiaton doses on sterility (%) in rapeseed genotypes

	Observations				
Genotype	Deform stamen	Deform flower	Polycorpus flower	Changed ideotype	Total
Abasin-95	26	35	12	85	158
Durr-e- NIFA	30	37	13	85	165
Punjab Sarsoon	21	35	16	72	144
NH 97-5/2-4	17	31	10	86	144
04 K 12/13-10-1	15	36	14	79	144
Hyola-401	19	30	15	77	141
NR-2-1/09	22	31	10	84	147
NR-21/09	28	34	16	84	162
NR-23/09	18	32	11	78	139
NR-28/09	32	38	15	87	172
Total	228	339	132	817	1516

A note on the oldest material evidence of *Brassicaceae* in Near East and Europe

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There are numerous archaeological sites in Near East where the remains of various genera and species of the family *Brassicaceae* were found. A general opinion is that the genera *Brassica* and *Sinapis* were domesticated rather early and that provided oil, flavourings and leaves for millennia. The earliest evidence for deliberate collecting of *Brassica* and *Sinapis* seeds and their possible use as food comes from the site Jerf el Ahmar in Syria, dated at 10th millennium BP (before present).

It is rather certain that the brassicas followed cereals, legumes and other domesticated plant species on their spreading in all directions from the Fertile Crescent. One of them was towards Europe, recently released from boreal climate after the end of the last Ice Age, via Asia Minor. Among the most significant archaeological sites for the brassica crop history is Çatalhöyük East, in modern Turkey, dated at 6200-6600 BC (Fig. 1, left). Here the seeds of both *Brassica* and *Sinapis* were used for extracting oil for daily use, as a spice and probably in ritual purposes (Fairbarn et al. 2007).

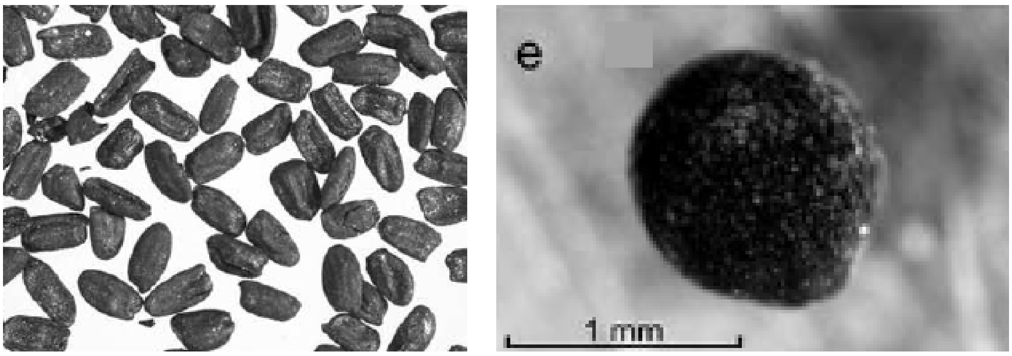

Figure 1. (left) *Brassicaceae* seeds from Mellaart Archive sample 24 (Fairbarn et al. 2007); (right) waterlogged *Brassica rapa* seeds (Tolar et al. 2010)

The most ancient remains of *Brassicaceae* in Europe are mostly from wild flora, dated in early or middle Neolithic. It is supposed that they were collected for various used, in a way repeating the process of domestication. Among numerous sites, it is noteworthy to mention the following ones:

- 5100-3500 BC. Lagozza di Besnate, northern Italy, *Brassica rapa* (Rottoli & Castiglioni 2009)

- 4400-4000 BC. Le Chenet des Pierres, the valley of Bozel, France, *Brassica* and *Sinapis* (Martin et al. 2008)
- 3200 BC. Stare gmajne, Ljubljansko barje, Slovenia, *Brassica rapa* (Fig. 1, right, Tolar et al. 2010)
- 2930-2880 BC. Jevišovice, Kleiner Anzingerberg, Austria, *Brassica rapa* (Kohler-Schneider & Canappele 2009)

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Forage dry matter crude protein yield in the intercrops of spring-sown brassicas with legumes

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Introduction

Intercropping may be considered a practice of growing of at least two different plant species at the same place and the same time. It is surely one of the most ancient agricultural practices (Hauggaard-Nielsen et al. 2011). One of the most traditional ways of intercropping in temperate regions is the one that includes cereals and annual legumes (Bedoussac & Justes 2010).

Quite little is known on intercropping brassicas with legumes, although certain recent results demonstrate multiple benefits for a brassica component, such as much easier uptake of less available nutrients due to a positive influence of its legume companion (Cortés-Mora et al. 2010).

The goal of this study was to examine the potential of intercropping autumn-sown brassicas with legumes for forage dry matter crude protein yield.

Material and Methods

A small-plot trial was performed in the seasons of 2011/2012 and 2012/2013 at the Experimental Field of the Institute of Field and Vegetable Crops at Rimski Šančevi, including eight intercrops of autumn-sown brassicas and autumn-sown annual legumes and their sole crops. The rapeseed (*Brassica napus* L. var. *napus*) cv. Jovana and the white mustard (*Sinapis alba* L.) cv. NS Gorica played the role of supporting crops for four legumes, namely pea (*Pisum sativum* L.) cv. Jantar, common vetch (*Vicia sativa* L.) cv. Perla, and grass pea (*Lathyrus sativus* L.) cv. Sitnica, acted as supported crops.

In both seasons, all intercrops and sole crops were sown in early March, at a double reduced rate in the intercrops than those in the sole crops: 20 viable seeds m^{-2} for rapeseed and white mustard, 50 viable seeds m^{-2} for pea and grass pea and 60 viable seeds m^{-2} for common vetch. The brassicas were cut in full budding, while the annual legumes were cut in full bloom.

Forage dry matter crude protein yield (kg ha^{-1}) was determined in all intercrops sole crops. The land equivalent ratio (LER) for forage dry matter crude protein yield was calculated according to the following formula:

$LER = B_{IC} / B_{SC} + L_{IC} / L_{SC}$,

where B_{IC} is the forage dry matter crude protein yield of a brassica component in an intercrop, B_{SC} is the forage

dry matter crude protein yield of a brassica component in its sole crop, L_{IC} is the forage dry matter crude protein yield of a legume component in an intercrop and L_{SC} is the forage dry matter crude protein yield of a brassica component in its sole crop.
The obtained results were processed by analysis of variance (ANOVA) with the Least Significant Difference (LSD) test.

Results and Discussion

There were significant differences in two-year average forage dry matter crude protein yield in both intercrops and sole crops, as well as in the two-year average values of LER (Table 1).
Among the sole crops, the highest forage dry matter crude protein yield was in grass pea (2045 kg ha^{-1}), while the lowest forage dry matter crude protein yield was in rapeseed (1067 kg ha^{-1}). Among the intercrops of forage brassicas and annual legumes, the average two-year average values of forage dry matter crude protein yield varied between 1114 kg ha^{-1} in the intercrop of white mustard and Narbonne vetch and 2201 kg ha-1 in the intercrop of white mustard and grass pea. The majority of both sole crops and intercrops of forage brassicas and annual legumes had higher average forage dry matter crude protein yield in comparison to the average values of grass pea, with 1457 kg ha^{-1} (Mikić et al. 2011), or lentil, with 641 kg ha^{-1} (Mihailović et al. 2012).
All the intercrops had the average two-year values of LER higher than 1 and thus proved to be economically reliable.

Conclusion

The spring-sown intercrops of forage brassicas with annual legumes proved to have a considerable potential for producing forage dry matter crude protein and thus be a source of quality forage in feeding ruminants. The next step should target the assessment of the optimal sowing ratio between these two botanically different components.

Acknowledgements

The Projects TR-31016, TR-31024 and TR-31025 of the Ministry of Education, Science and Technological Development of the Republic of Serbia.

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Table 1. Two-year average values of forage dry matter crude protein yield (kg ha^{-1}) and its land equivalent ratio (LER) in pure stands and intercrops of spring-sown brassicas and legumes at Rimski Šančevi for 2011/2012 and 2012/2013

Sole crop / Intercrop	Brassica forage dry matter crude protein yield	Legume forage dry matter crude protein yield	Total forage dry matter crude protein yield	LER
Rapeseed	1067	-	-	-
White mustard	1183	-	-	-
Pea	-	1502	-	-
Common vetch	-	1358	-	-
Narbonne vetch	-	1068	-	-
Grass pea	-	2045	-	-
Rapeseed + pea	615	975	1590	1.23
Rapeseed + common vetch	652	839	1490	1.23
Rapeseed + Narbonne vetch	579	663	1242	1.16
Rapeseed + grass pea	525	1365	1890	1.16
White mustard + pea	380	1151	1531	1.09
White mustard + common vetch	471	878	1348	1.04
White mustard + Narbonne vetch	471	644	1114	1.00
White mustard + grass pea	290	1911	2201	1.18
$LSD_{0.05}$	117	99	110	0.07

Intercropping spring-sown brassicas with cereals for forage production

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Introduction

Numerous authors define intercropping as a practice of cultivating of at least two different cultivated plant species at the same place and time. It is also one of the oldest agricultural practices worldwide (Hauggaard-Nielsen et al. 2011).

One of the most traditional ways of intercropping for forage production in temperate regions is the one that includes annual legumes and cereals (Bedoussac & Justes 2010). However, this is often used for grain production, leaving a quite scarce knowledge on the possibility of its use in forage production.

This study was aimed at assessing the potential of intercropping various autumn-sown brassicas and cereals for forage production.

Material and Methods

A small-plot trial has been performed in the trial years of 2011 and 2012 at the Experimental Field of the Institute of Field and Vegetable Crops at Rimski Šančevi near Novi Sad. It included eight intercrops of autumn-sown brassicas with autumn-sown annual legumes. Two brassicas, namely (*Brassica napus* L. var. *napus*) and white mustard (*Sinapis alba* L.), were mixed with three cereals, oat (*Avena sativa* L.), barley (*Hordeum vulgare* L.) and common wheat (*Triticum aestivum* L. subsp. *aestivum*), respectively. All five species were sown as sole crops as well.

All six intercrops and all five sole crops were sown in the first week of March, at a double reduced rate in the intercrops in comparison to those in the sole crops, as a measure that would avoid an expensive sowing. The sole crops of two forage brassicas were cut in the stages of full budding and beginning of flowering, while the sole crops of three cereals were cut few days before spikes or racemes would have appeared. Six intercrops were cut when both a forage brassica or cereal component was ind its own optimum stage, in both seasons happening at the same time.

Forage dry matter yield (t ha^{-1}) was determined in all six sole crops and their eight intercrops, while for the latter the corresponding land equivalent ratio for forage dry matter yield (LER) was calculated according to the following formula:

$LER_{FDMY} = B_{IC} / B_{SC} + C_{IC} / C_{SC}$,

where B_{IC} is the forage dry matter yield of a brassica component in an intercrop, B_{SC} is the forage dry matter yield of a brassica component in its sole crop, C_{IC} is the forage dry matter yield of a cereal component in an intercrop and C_{SC} is the forage dry matter yield of a ceral component in its sole crop.

The research results were processed by analysis of variance (ANOVA) together with the Least Significant Difference (LSD) test.

Results and Discussion

There were significant differences in both two-year average values of forage dry matter yield in eight intercrops and six sole crops and the two-year average values of LER (Table 1).

The two-season average values of in sole crops varied between 6.9 t ha^{-1} in white mustard and 9.4 t ha^{-1} in barley. The highest average two-season forage dry matter yield among the intercrops of the spring-sown forage brassicas and cereals was in the intercrop of rapeseed and barley (10.2 t ha^{-1}), while the lowest average two-season forage dry matter yield among the intercrops of the spring-sown forage brassicas and cereals was in the intercrop of white mustard and common wheat (6.6 t ha^{-1}) and the intercrop of white mustard and oat (6.5 t ha^{-1}). The highest two-year average individual contribution in the total forage dry matter yield among brassicas was in rapeseed (3.9 t ha^{-1}) in the intercrop with oat. The highest individual contribution in the total forage dry matter yield among cereals was in barley (8.0 t ha^{-1}) when intercropped with rapeseed.

The intercrop of rapeseed and barley had significantly higher two-year average LER value (1.17) in comparison to the remaining seven intercrops, all of which had their two-year average LER values higher than 1. These results are similar to those obtained in the trials with mutual annual legume intercropping (Ćupina et al. 2011) and intercropping annual legumes with cereals (Mihailović et al. 2011) in the same agroecological conditions.

Conclusion

The spring-sown intercrops of forage brassicas with cereals have a considerable potential for forage production and its use in feeding ruminants. It is notable that rapeseed has a better ability to compete with cereals when intercropped together. Among the remaining issues related to intercropping spring-sown brassicas with cereals the most important is forage quality.

Acknowledgements

The Projects TR-31016, TR-31024, TR-31025 and TR-31066 of the Ministry of Education, Science and Technological Development of the Republic of Serbia.

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Table 1. Two-year average values of forage dry matter yield (t ha^{-1}) and its land equivalent ratio (LER) in pure stands and intercrops of spring-sown brassicas and cereals at Rimski Šančevi for 2010/2011 and 2011/2012

Pure stand / Intercrop	Brassica forage dry matter yield	Cereal forage dry matter yield	Total forage dry matter yield	LER
Rapeseed	7.5	-	-	-
White mustard	6.9	-	-	-
Oat	-	8.3	-	-
Barley	-	9.4	-	-
Common wheat	-	7.5	-	-
Rapeseed + oat	3.9	4.3	8.2	1.08
Rapeseed + barley	2.2	8.0	10.2	1.17
Rapeseed + common wheat	3.5	3.9	7.4	1.03
White mustard + oat	1.9	4.6	6.5	1.01
White mustard + barley	1.2	7.8	9.0	1.12
White mustard + common wheat	2.2	4.4	6.6	1.11
$LSD_{0.05}$	0.5	0.9	0.8	0.03

Forage dry matter crude protein yield in the intercrops of autumn-sown brassicas with legumes

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Introduction

Intercropping may be regarded as a practice of cultivating at least two plant species at the same place and the same time. Intercropping is one of the oldest agricultural practices in the world (Hauggaard-Nielsen et al. 2011). One of the most traditional intercropping forms in temperate regions, such as Europe, is growing a mixture of cereals and annual legumes (Bedoussac & Justes 2010).

The knowledge on intercropping brassicas with legumes is not extensive and the literary resources are still rather limited. There are some recent and encouraging reports on multiple benefits for a brassica component, since its legume companion makes the uptake of less available nutrients much easier (Cortés-Mora et al. 2010).

This research was aimed at examining the potential of intercropping autumn-sown brassicas with legumes for producing forage dry matter crude protein yield.

Material and Methods

A small-plot trial was carried out in the seasons of 2011/2012 and 2012/2013 at the Experimental Field of the Institute of Field and Vegetable Crops at Rimski Šančevi. There were eight intercrops of autumn-sown brassicas and autumn-sown annual legumes: fodder kale (*Brassica oleracea* L. var. *viridis* L.) cv. Perast and the rapeseed (*Brassica napus* L. var. *napus*) cv. Zorica were supporting crops, while the pea (*Pisum sativum* L.) cv. NS Krmni, the common vetch (*Vicia sativa* L.) cv. NS Tisa, Hungarian vetch (*Vicia pannonica* Crantz) cv. Panonka and the hairy vetch (*Vicia villosa* Roth) cv. NS Viloza were supported crops. All six cultivars were also included in the trial as sole crops.

In both years, all intercrops and sole crops were sown in the last week of September, at a double reduced rate in the intercrops in comparison to those in the sole crops: 25 viable seeds m^{-2} for fodder kale, 15 viable seeds m^{-2} for rapeseed, 60 viable seeds m^{-2} for pea and 75 viable seeds m^{-2} for common, Hungarian and hairy vetches. The sole crops of the brassicas were cut in full budding, while the sole crops of the annual legumes were cut in full bloom. The intercrops were cut when either brassica or legume component reached these optimum stages.

Forage dry matter crude protein yield (kg ha^{-1}) was determined in all sole crops and intercrops, with the land equivalent ratio (LER) for forage dry matter crude protein yield calculated according to the following formula:
$LER = B_{IC} / B_{SC} + L_{IC} / L_{SC}$,
where B_{IC} is the forage dry matter crude protein yield of a brassica component in an intercrop, B_{SC} is the forage dry matter crude protein yield of a brassica component in its sole crop, L_{IC} is the forage dry matter crude protein yield of a legume component in an intercrop and L_{SC} is the forage dry matter crude protein yield of a brassica component in its sole crop.
The research results were processed by analysis of variance (ANOVA) with the Least Significant Difference (LSD) test applied.

Results and Discussion

Significant differences in both two-year average forage dry matter crude protein yield in intercrops and sole crops existed, as well as in the two-year average values of LER (Table 1).
The average two-year average values of forage dry matter crude protein yield among the intercrops of forage brassicas and annual legumes ranged from 1012 kg ha^{-1} in the intercrop of rapeseed and Hungarian vetch to 1996 kg ha^{-1} in the intercrop of rapeseed and hairy vetch. Some of the intercrops of forage brassicas and annual legumes had higher forage dry matter crude protein yield than diverse annual legumes, such as grass pea (*Lathyrus sativus* L.), with an average value of 1457 kg ha^{-1} (Mikić et al. 2011). Hairy vetch had the highest average forage dry matter crude protein yield among the sole crops, with 1919 kg ha^{-1}.
Most intercrops proved to be economic reliable, with the average values of LER higher than 1.

Conclusion

The autumn-sown intercrops of forage brassicas with annual legumes may be considered a good source of quality forage rich in protein in feeding ruminants. The future research should be aimed at studying more agronomic aspects, such as the optimal sowing ratio between these two components.

Acknowledgements

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Table 1. Two-year average values of forage dry matter crude protein yield (kg ha^{-1}) and its land equivalent ratio (LER) in sole crops and intercrops of autumn-sown brassicas and legumes at Rimski Šančevi for 2011/2012 and 2012/2013

Sole crop / Intercrop	Brassica forage dry matter crude protein yield	Legume forage dry matter crude protein yield	Total forage dry matter crude protein yield	LER
Fodder kale	1242	-	-	-
Rapeseed	1183	-	-	-
Pea	-	1720	-	-
Common vetch	-	1611	-	-
Hungarian vetch	-	1339	-	-
Hairy vetch	-	1919	-	-
Fodder kale + pea	634	956	1589	1.07
Fodder kale + common vetch	652	839	1490	1.05
Fodder kale + Hungarian vetch	652	585	1237	0.96
Fodder kale + hairy vetch	507	1385	1891	1.13
Rapeseed + pea	579	936	1515	1.03
Rapeseed + common vetch	615	722	1337	0.97
Rapeseed + Hungarian vetch	525	488	1012	0.81
Rapeseed + hairy vetch	416	1580	1996	1.18
$LSD_{0.05}$	98	105	101	0.05

Intercropping autumn-sown brassicas with cereals for forage production

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Introduction

In accordance with a majority of the definitions by various authors, intercropping could be considered a practice of growing of two or more different cultivated plant species or varieties at the same place and time and is most likely one of the most ancient agricultural practices (Hauggaard-Nielsen et al. 2011).

Among the most traditional intercropping systems in temperate regions, such as West Europe, is the mixture of annual legumes and cereals (Bedoussac & Justes 2010). Very little is known on the potential of intercropping brassicas and cereals for forage production.

The goal of this study was to assess the potential of intercropping various autumn-sown brassicas and cereals for forage production.

Material and Methods

A small-plot trial has been carried out in 2010/2011 and 2011/2012 at the Experimental Field of the Institute of Field and Vegetable Crops at Rimski Šančevi in the vicinity of Novi Sad. It included eight intercrops of autumn-sown brassicas with autumn-sown annual legumes. Two brassicas, fodder kale (*Brassica oleracea* L. var. *viridis* L.) and rapeseed (*Brassica napus* L. var. *napus*) were intercropped with four cereals, namely oat (*Avena sativa* L.), barley (*Hordeum vulgare* L.), triticale (×*Triticosecale* spp.) and common wheat (*Triticum aestivum* L. subsp. *aestivum*). All six species, were also sown as sole crops.

In both years, all eight intercrops of forage brassicas and cereals and their six sole crops were sown in the last week of September, at a double reduced rate in the intercrops in comparison to those in the sole crops, in order to reduce the sowing costs. The sole crops of the forage brassicas were cut in the stages of full budding and beginning of flowering, while the sole crops of the cereals were cut just before spikes or racemes appeared. The intercrops were cut when either brassica or cereal component reached their own optimum stage. In both trial years, this happened concurrently.

Forage dry matter yield (t ha^{-1}) was determined in all six sole crops and their eight intercrops, while for the latter the corresponding land equivalent ratio for forage dry matter yield (LER) was calculated according to the following formula:

$LER = B_{IC} / B_{SC} + C_{IC} / C_{SC}$,

where B_{IC} is the forage dry matter yield of a brassica component in an intercrop, B_{SC} is the forage dry matter yield of a brassica component in its sole crop, C_{IC} is the forage dry matter yield of a cereal component in an intercrop and C_{SC} is the forage dry matter yield of a ceral component in its sole crop.

The obtained study results were processed by analysis of variance (ANOVA), applying the Least Significant Difference (LSD).

Results and Discussion

Significant differences existed at a level of 0.05 in both two-season average values of forage dry matter yield in both intercrops and sole crops, as well as in the two-season average values of LER (Table 1).

A two-season average value of the forage dry matter yield in the sole crop of fodder kale (7.5 t ha^{-1}) was significantly higher in comparison to the results of a trial in the same environment, with 4.1 t ha^{-1} (Ćupina et al. 2010). The highest two-season average individual contribution in the total forage dry matter yield among forage brassicas was in fodder kale (4.3 t ha^{-1}) in the intercrop with common wheat. The highest two-season average individual contribution in the total forage dry matter yield among cereals was in barley (7.7 t ha^{-1} and 7.6 t ha^{-1}) in the intercrops with rapeseed and fodder kale respectively.

The two-year average values of LER ranged from 1.02 in the intercrops of fodder kale with common wheat and rapeseed with oat to 10.9 in the intercrop of fodder kale and barley. A slight majority of the intercrops had the values of LER less than 1 and thus may be considered not economically reliable.

Conclusion

The intercrops of the autumn-sown forage brassicas and cereals may produce high forage dry matter and used as fresh forage in feeding ruminants. Some intercrops have a great potential for forage production. A detailed study on the quality of the forage dry matter in the intercrops of the autumn-sown forage brassicas and cereals is required along with other important issues.

Acknowledgements

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Table 1. Two-year average values of forage dry matter yield (t ha^{-1}) and its land equivalent ratio (LER) in pure stands and intercrops of autumn-sown brassicas and cereals at Rimski Šančevi for 2010/2011 and 2011/2012

Pure stand / Intercrop	Brassica forage dry matter yield	Cereal forage dry matter yield	Total forage dry matter yield	LER
Fodder kale	7.5	-	-	-
Rapeseed	6.9	-	-	-
Oat	-	9.2	-	-
Barley	-	10.4	-	-
Triticale	-	10.1	-	-
Common wheat	-	8.5	-	-
Fodder kale + oat	4.0	5.1	9.1	1.09
Fodder kale + barley	3.3	7.6	10.9	1.17
Fodder kale + triticale	3.5	6.7	10.2	1.13
Fodder kale + common wheat	4.3	3.8	8.1	1.02
Rapeseed + oat	3.5	4.7	8.2	1.02
Rapeseed + barley	2.8	7.7	10.5	1.15
Rapeseed + triticale	3.1	6.6	9.7	1.10
Rapeseed + common wheat	3.9	4.7	8.6	1.12
$LSD_{0.05}$	0.5	0.9	0.8	0.03

CRUCIFERAE NEWSLETTER Nr. 34

Instructions to the authors – 2014

Deadline for contribution submission: **December 1st 2014**

The current issue of the Cruciferae Newsletter (vol. 34) will be published online at the beginning of year 2015 from the Brassica website (http://www.brassica.info/info/publications/cruciferae-newsletter.php). Online process will ensure rapid publication of your contribution. Therefore, we should be grateful if you would, please, follow the instructions below.

1- All contributions should be written in **English**.

2- Authors should submit manuscripts only by email to **cruciferaenewsletter@rennes.inra.fr**. A manuscript file in Microsoft Word (or some other word processing format) is required. The manuscript file must be named as following: Full name of the first author_Year of submission.doc or .rtf.

3- As previously contributions must not exceed **2 pages**, including tables, figures and photographs. **Arial 10** character is expected with single spacing (**please use the submission form below**).

4- The heading of the paper must be written in boldface letters and must include the title (1st line), followed by the author names (lines below) and their address (3rd lines) with the email address of the corresponding author.

5- Tables, figures and photographs must be included in, or at the end of the text.

6- While submitting their contributions, authors should mention **one of the listed topics** that is the most relevant to their work (see the list below), in order to facilitate the editing process.

7- All papers are published on their author's responsibility.

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Other topics (please give two keywords)

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Table 1. Title

Figure 1. Title