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Effect of Seeding Rates of the Mixture of Rye (*Secale cereale* L.) and Hairy Vetch (*Vicia villosa* Roth.) on Rye Yield

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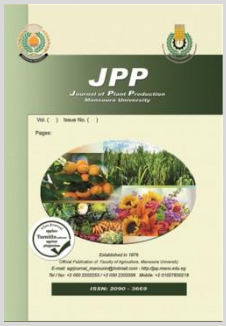

ABSTRACT

The research work was carried out under sandy soil of Research Institute of Nyíregyhaza, IAREF, University of Debrecen, Hungary. The purpose of this study was aimed to know the impact of seeding rates of the mixture of rye and hairy vetch on rye productivity. These studies contained 28 treatments, included four seeding rates of rye plant was (20, 40, 60 and 80 kg ha^{-1}) and seven seeding rates of hairy vetch (20, 30, 40, 50, 60, 70 and 80 kg ha^{-1}) treatments were arranged in Randomized Complete Block Design with four replicates. The highest average of NDVI value (0,701) and the highest harvested seed yield 4432 kg ha^{-1} were resulted with H1R4 seed mixture. Sowing the H3R4 resulted in the highest biomass yield of 37,466 kg ha^{-1}. The application of the H5R4 seed mixture had the highest dry matter mass with an amount of 3.41 grams. On the other hand, the smallest average NDVI value of 0.643 resulted from H1R1 seed mixture. Sowing the H2R1 seed mixture resulted the lowest biomass yield 24,800 kg ha^{-1} and the lowest seed quantity of 2926 kg ha^{-1}. H4R1 seed mixture had the lowest dry matter weight with an amount of 2.86 grams. Based on the Pearson's correlation test, there was a correlation of 0.476 between the average NDVI and the average biomass. There was a correlation of 0.703 between the average NDVI and the average seed yield. There was a correlation of 0.606 between the average dry matter mass and the average seed yield.

Keywords: Rye, hairy vetch, mixture, productivity.

INTRODUCTION

Mixed sowing of rye and hairy vetch is widespread on several continents, including Europe and North America (Kutasy, 2019). Vetch is sown with a supporting plant of rye on sandy soil, both cultures can be said to be undemanding and therefore can be grown in more difficult conditions (Radics and Pusztai, 2011). The harvested area of rye in the world was estimated at 4,44,6927 ha^{-1}, with a yield of 150,222,173 tons. The cultivated area of vetch species in the world was estimated at 353,630 ha^{-1}, with a total yield of 711,203 tons in 2020. Rye was harvested on 19,147 ha^{-1}, with 57,581 tons in Hungary (FAO, 2022). Vetch species were grown on 25 hectares with a yield of 12 tons in Hungary (FAO, 2022). Several literatures have reported the benefits of cereal-legume mixtures, such as weed control, increased total dry matter production and nitrogen availability, compared to green manure monoculture (Clark *et al.*, 2007; Lithourgidis *et al.*, 2011 and Baraibar *et al.*, 2018). Furthermore, the synergy existing during the sowing of the rye-vetch biculture can mitigate the weakness of the monoculture cultivation of certain plant species (Zandvakili *et al.*, 2020). Based on the results of 21 studies in the United States, the researchers prepared a meta-analysis on how the N content and biomass amount of rye-hairy vetch mixtures changes compared to monoculture cultivation. In the course of the research, it was determined that the sowing of the hairy vetch-rye biculture offers the farmer more agro-ecosystem opportunities (weed suppression, erosion control, N-retention, and N-supply), compared to species sown in monoculture, by accumulating as much nitrogen, like hairy vetch in pure seeding, and produces equal or more biomass than the two plants in monoculture cultivation. Based on the researchers' investigation, the biculture of rye-hairy vetch is recommended over monoculture cultivation in the event that the goal of the cultivation is to maximize the biomass and nitrogen content of both plant cultures and also we want to release nitrogen for next crop (Thapa *et al.*, 2018). Many international literatures focus on the setting of optimal seed ratios. Different proportions of species in cereal and legume mixtures can affect plant production (Poffenbarger, 2015). In the central region of Korea, research was carried out on the setting of optimal rye-hairy vetch grain ratios. The goal of the research was to achieve maximum production. The mixture with the best seeding rate to achieve maximum biomass was 6.75 kg of hairy vetch and 5 kg of rye at 0.1 ha^{-1} (Weon-Tai *et al.*, 2009). Research was carried out at the University of Washington in 2004 regarding the results achieved by rye-hairy vetch biculture in different grain rates, different sowing times and with different harvesting times during organic farming. During the study, they worked with the following proportions: 100% pure hairy vetch, 25% rye and 75% hairy vetch, 50% rye and 50% hairy vetch, and

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100% pure rye. During the research, it was determined that the weeds made up a smaller part of the biomass of the mixtures, while the mass of the weeds was 20% in the case of the mixtures, while it was 29% in the case of monoculture cultivation. The fodder mixtures resulted in a more secure balance between biomass accumulation and nitrogen concentration. During the six-year study, the use of mixed feeds yielded a more uniform biomass, and winter weeds were also better suppressed compared to monocultures (Lawson *et al.*, 2015).

Therefor our study aimed to know the impact of seeding rates of the mixture of rye and hairy vetch on rye productivity.

MATERIALS AND METHODS

The area, data and main purpose of our research

The research was carried out on the sandy soil of Research Institute of Nyíregyhaza, IAREF, University of Debrecen in Hungary where the seed was sown in 20 of October in 2021. The purpose of the study is to investigate the combinations of different rye and hairy vetch seed quantities regarding biomass and yield. The soil of the area was acidic with a pH value of 6.21. Based on soil plasticity according to Arany, the physical soil type was sandy soil. Based on total water-soluble salts, the soil had a low salt content. Regarding the lime content, the experiment was carried out on weakly calcareous soil. The humus content of soil was medium. Both phosphorus and potassium supply were very good in this area. The amount of nitrate in the soil was 120 mg/kg (Szakál *et al.*, 2006). The pre-seeding crop was corn (*Zea mays* L.) in the area. The size of one plot was 15.64 m^{-2}, we worked with four repetitions in a randomized complete blocks design (RCBD). Four different rye seed rates were combined with seven hairy vetch seed rates. Table 1 shows the quantities of rye seeds. Table 2 shows the quantities of hairy vetch seeds. Rye-hairy vetch mixtures are shown in Table 3.

Table 1. Different amounts of rye seeds with codes.

Codes	Doses(kg ha^{-1})
R1	20
R2	40
R3	60
R4	80

Table 2. Different amounts of hairy vetch seeds with codes.

Codes	Doses (kg ha^{-1})
H1	20
H2	30
H3	40
H4	50
H5	60
H6	70
H7	80

Normalized Differential Vegetation Index measurements

The NDVI measurements 8 times using the Trimble Green-Seeker HCS-100 hand-held measuring instrument between April 21st and June 7th was performed. In recent years, sensors for measuring the NDVI of the leaves of plants grown in agriculture have become commercially available, such as the low-cost Green-Seeker HCS-100 handheld meter (White *et al.*, 2019). Moving along the left side of the plot rows, we documented the data once and then again on the right side, so that two data were recorded from one plot. It is important to note that the holes from the biomass recording on May 10th, 2022 influenced the results of further NDVI measurements.

Table 3. Different combinations ratios of hairy vetch-rye ration

Serial number	Codes
1	H1R1
2	H1R2
3	H1R3
4	H1R4
5	H2R1
6	H2R2
7	H2R3
8	H2R4
9	H3R1
10	H3R2
11	H3R3
12	H3R4
13	H4R1
14	H4R2
15	H4R3
16	H4R4
17	H5R1
18	H5R2
19	H5R3
20	H5R4
21	H6R1
22	H6R2
23	H6R3
24	H6R4
25	H7R1
26	H7R2
27	H7R3
28	H7R4

Biomass and dry matter weight % measurements

Plant sample collection was taken using a 50 x 50 cm sampling frame (above-ground plant parts) for biomass mapping with one repetition per plot on 10 May. The collected samples were weighed immediately, thus avoiding the drying process. 20-gram samples were taken uniformly from the plants collected for the purpose of biomass determination, and then dried to a constant weight. After that, the weight % of the dry material was measured.

Harvesting and determination of grain moisture content

After 267 days from sowing, the harvest took place on July 14th. We harvested all 126 plots including the border. Before the harvest, we checked the position of the stakes marking the plots, however, both the pre-harvest preparation and the harvest itself were made more difficult by the fact that the rye was specifically tilted in the area. After harvesting, we documented the grain moisture content once for each different seed mixture.

Our study used to prove that applied sciences are highly significant in life because of their various applications in the present and in the past (Abido and Zsombik, 2018; Abido and Zsombik, 2019; Abido *et al.*, 2021).

The statistical analysis

The data was recorded using the MS Excel program. The statistical analysis was carried out using the IBM SPSS Statistics V22 statistical software. Descriptive statistics, Post Hock test and one-factor variance analysis were

performed from the collected data. A homogeneity test was performed using the Duncan test, and the results were analysed using the Pearson correlation test.

RESULTS AND DISCUSSION

Results of the Normalized Differential Vegetation Index

We performed NDVI measurements eight times; the first measurement was on April 21st. According to the results shown in Fig. 1 the seed mixture coded H1R4 was the most prominent with an NDVI value of 0.74. The following 5 highest NDVI values were also measured in the plots of seed mixtures with the highest rye ratio (H6R4 0,71; H4R4; 0,71; H5R4 0,71; H7R4 0,70, H3R4 0,70). The lowest NDVI value was found on the parcel coded H2R1 with an NDVI value of 0.52. This was followed by the mixture with the 6 smallest rye seed ratios (H1R1 0,53; H5R1 0,53, H3R1 0,54; H4R1 0,58; H6R1 0,59; H7R1 0,60).

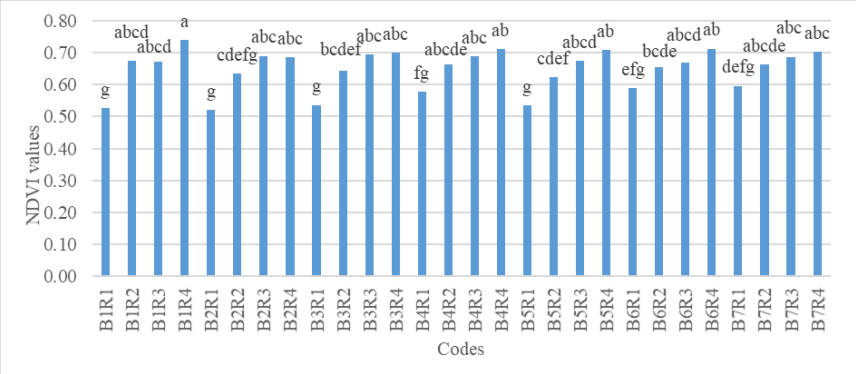

Figure 1. NDVI values in the rye-hairy vetch experiment.
(Nyíregyháza, 21.04.2022.)

The next NDVI data recording was on April 27th. Several plots also showed the highest NDVI value during the surveys. Like the recording on April 21, the application of the H1R4 seed mixture resulted in the highest NDVI value (0.84). Like the previous NDVI data collection, here too the first 6 highest NDVI values were obtained by mixtures sown with the largest amount of rye. The two lowest NDVI values were shown by the mixtures with the lowest rye seed ratio: the NDVI value of the H1R1 and H2R1 mixtures was 0.70. This was followed by the remaining R1 rye ratio in the experiment. Fig. 2 illustrates the results.

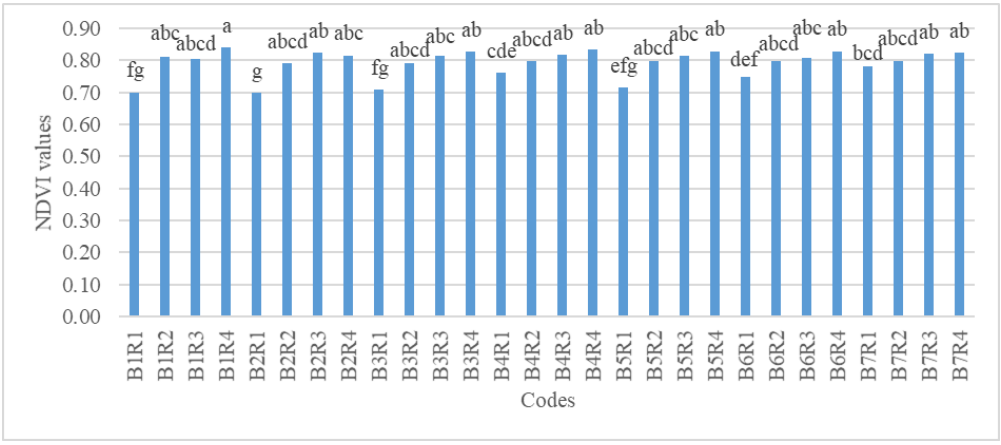

Figure 2. NDVI values in the rye-hairy vetch experiment
(Nyíregyháza, 27.04.2022.)

During the data collection on May 3rd, the highest three values of 0.82 were measured on plots H2R3 H5R3 and H7R2 and. The H1R4 seed mixture, which showed the highest NDVI values during the previous two recordings, decreased minimally from 0.84 to 0.80 compared to the previous recording value. The two lowest values with 0.78 were shown by the H2R4 and H3R1 seed mixtures. Compared to the previous recording time, we can see that the NDVI values of the plots sown in different grain ratios are much closer to each other. The NDVI data on May 3 is presented in Fig. 3.

Fig. 4 shows that, according to the NDVI data obtained during the recording on May 11, the average value of all plots sown with different seed mixtures decreased compared to the previous recording. The highest NDVI value (0.75) was measured on plots H6R3, H7R1 and H2R3. The lowest NDVI value was obtained by the H1R1 plots with 0.71, followed by the H2R2 and H1R3 plots. It can be seen that the difference between the highest and the lowest value is only 0.04 units, which is not much.

Fig. 5 illustrates the recording on May 18th, a further decrease in NDVI value followed. The highest value of 0.71 was measured on plots H6R1, H2R4, H7R3, H6R3 and H5R4. The lowest NDVI value was shown by plots H5R1 with an average of 0.67.

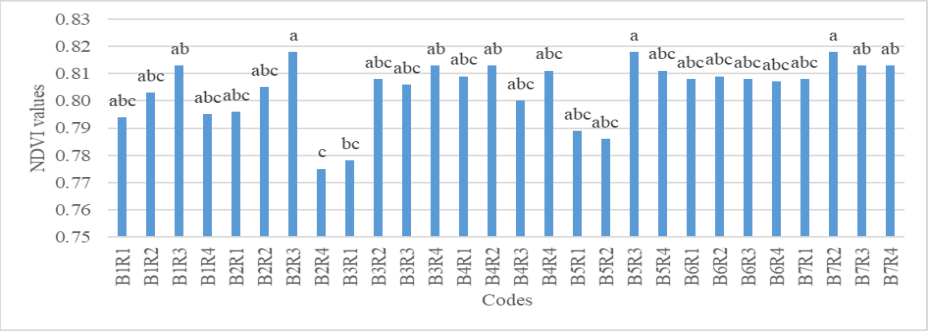

Figure 3. NDVI values in the rye-hairy vetch experiment
(Nyíregyháza, 03.05.2022.)

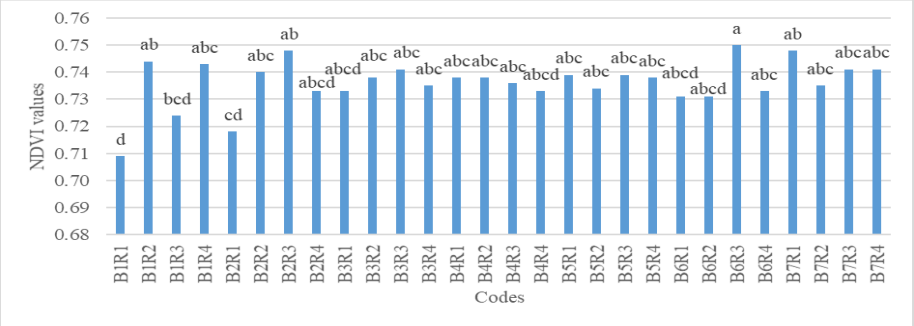

Figure 4. NDVI values in the rye-hairy vetch experiment
(Nyíregyháza, 11.05.2022.)

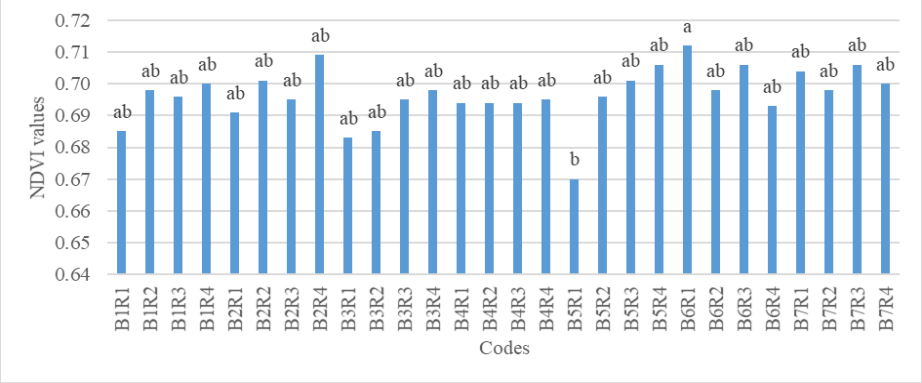

Figure 5. NDVI values in the rye-hairy vetch experiment
(Nyíregyháza, 18.05.2022.)

Fig. 6 shows the recording of the NDVI value on May 25th, here the value of 0.66 of the H3R3 seed mixture is outstanding. This was statistically different from the values of the other plots. The lowest value with 0.57 was shown by the seed mixtures H2R1, H5R1, H1R1 and H2R2.

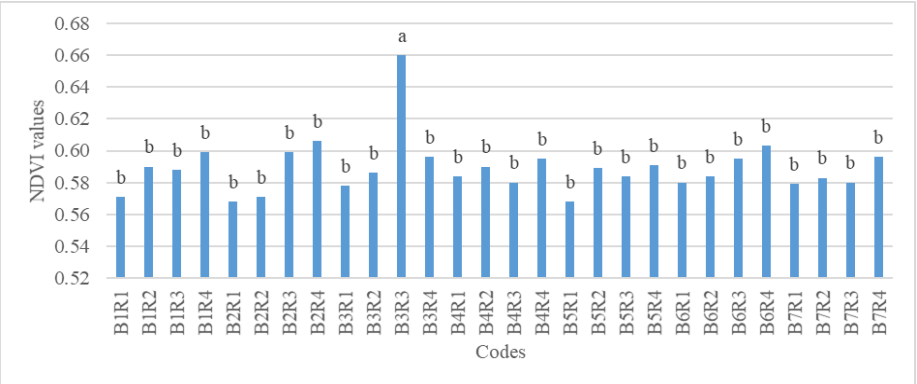

Figure 6. NDVI values in the rye-downy vetch experiment
(Nyíregyháza, 25.05.2022.)

During the admission on May 30th, there was some stagnation. The average values of the H4R3 seed mixture plots showed the highest maturity with 0.65. The lowest value with 0.61 was shown by the H1R1 and H6R1 seed mixtures. The admission on May 30 is illustrated in Fig. 7.

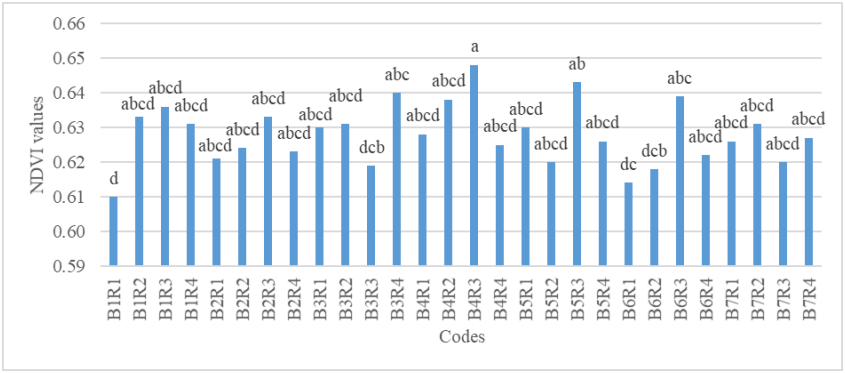

Figure 7. NDVI values in the rye-hairy vetch experiment (Nyíregyháza, 30.05.2022.)

The last NDVI value was recorded on June 7th. Compared to the recording on May 30th, the values have decreased. The highest value was the H4R1 seed mixture with 0.57, while the lowest value was the H7R4 treatment with 0.53. The admission on June 7th is illustrated in Fig. 8.

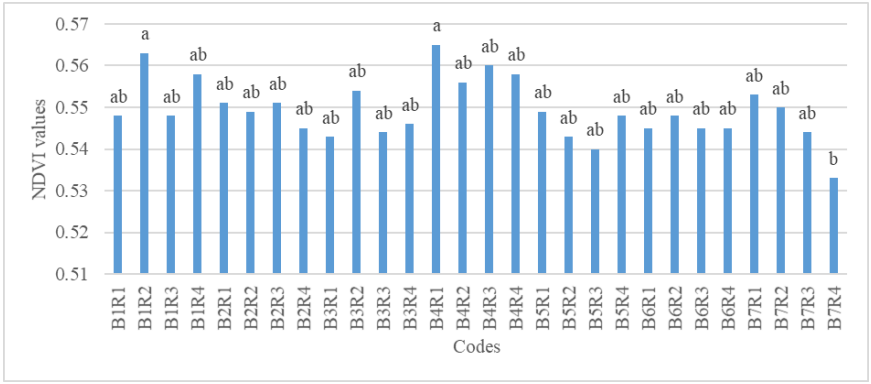

Figure 8. NDVI values in the rye-hairy vetch experiment (Nyíregyháza, 07.06.2022.)

Fig. 9 shows the average of the 8 NDVI recording sessions. Compared to the differences in the first two NDVI data recordings, the different seed mixes somewhat caught up with each other. Based on the average NDVI values, the H1R4 seed mixtures were the most outstanding with a value of 0.70. The lowest average value was obtained by the H1R1 seed mixture with 0.64. This was achieved by the seed mixture of H2R1, H3R1 and H5R1 with a value of 0.65.

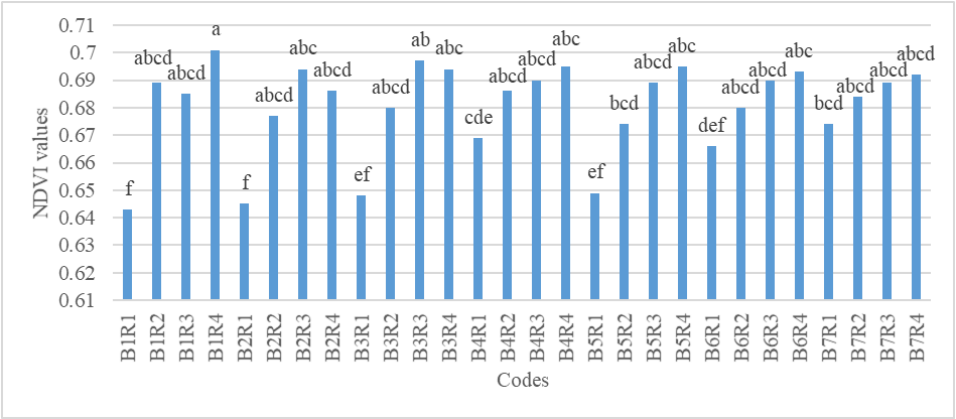

Figure 9. NDVI values in the rye-hairy vetch experiment (Nyíregyháza, 2022)

Biomass and dry matter weight % measurement results

The result of the biomass of the plant parts collected above the ground is illustrated in Fig. 10. The highest biomass yield of 37,466 kg ha^{-1} was resulted by sowing the H3R4 seed mixture. This was followed by the H4R4 seed mixture with a biomass yield of 36,250 kg ha-1, followed by the H6R4 seed mixture with a biomass yield of 33,360 kg ha^{-1}. The lowest biomass yield was measured at 24,800 kg ha^{-1} for the H2R1 seed mixture. Fig. 11 presents the measured dry matter masses, which were uniformly redried from 20 grams. The H5R4 seed mixture had the largest weight with 3.41 grams, and only the smallest seed mixture H4R1 with 2.86 grams differed from this statistically.

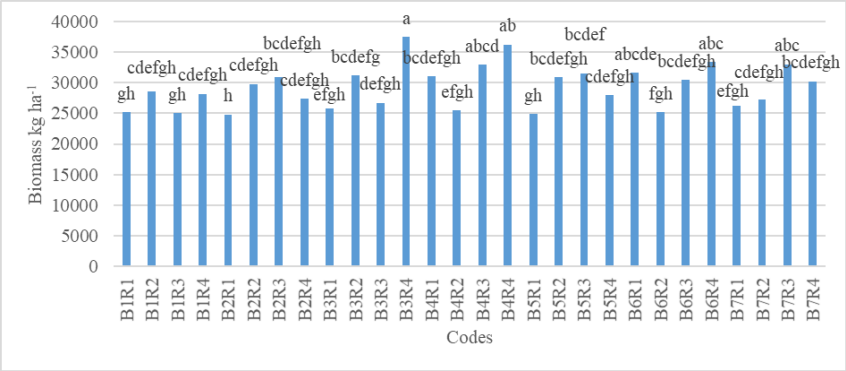

Figure 10. Biomass yield of rye-hairy vetch plants sown in different seed ratios (Nyíregyháza, 2022)

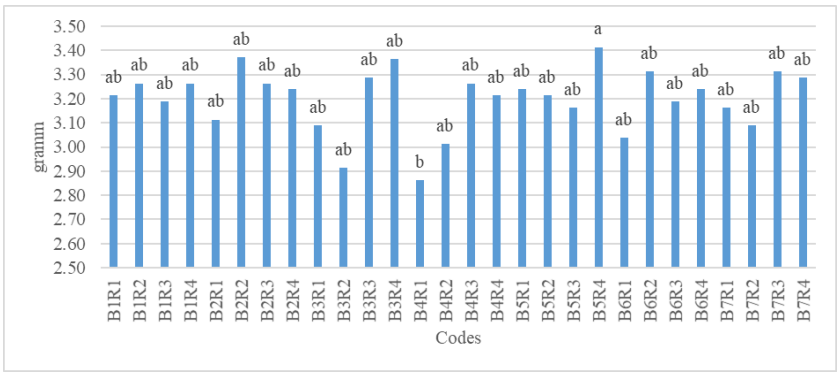

Figure 11. Dry matter mass of rye-downy vetch plants sown in different seed ratios (Nyíregyháza, 2022)

Seed yield of rye-hairy vetch sown in different seed ratios and grain moisture % measured at harvest.

During the experiment with rye-hairy vetch sown in different seed ratios, the highest seed yield with 4432 kg ha^{-1} resulted from sowing the H1R4 seed mixture. The lowest seed yield was achieved by the H2R1 treatment with 2926 kg ha^{-1}. This was followed by four more R1 treatments (H4R1, H7R1, H6R1, H3R1). Fig. 12 illustrates the seed yields of the rye-hairy vetch experiment sown in different seed ratios.

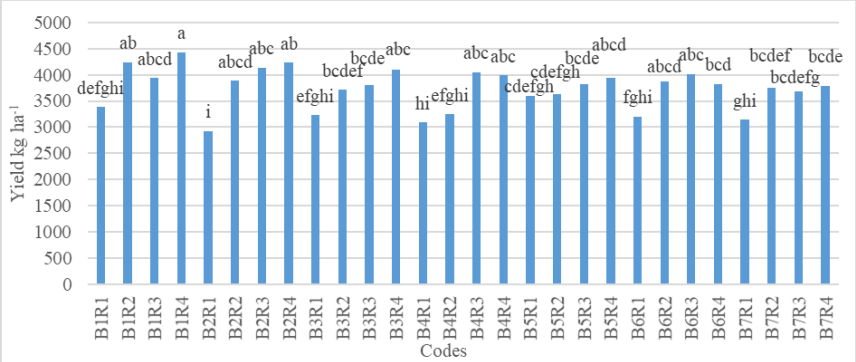

Figure 12. Seed yield of rye-downy vetch plants sown in different seed ratios (Nyíregyháza, 2022)

Table 4 illustrates the grain moisture % recorded once for each different seed mixture at harvest.

Table 5 shows a summary of the tested parameters. The H1R4 seed mixture yielded the highest average NDVI value (0.701) and the highest seed yield with 4432 kg ha^{-1}, however, it was not prominent in terms of biomass and dry matter mass.

The lowest NDVI average value (0.643) was obtained by the H1R1 seed mixture, it was not the last in the other indicators, however, it had an average biomass yield of 25,140 kg ha^{-1} after only three treatments. The highest biomass yield was obtained by the H3R4 seed mixture with 37,466 kg ha^{-1}, as well as the other parameters, NDVI (0.694), dry matter mass (3.36 grams), seed yield (4104 kg ha^{-1}), which were also outstanding and statistically not different from the seed mixtures showing the highest value.

The lowest average biomass yield was shown by the H2R1 seed mixture with 24,800 kg ha^{-1}, and this seed mixture also had the lowest average seed yield of 2,926 kg ha^{-1}. The H5R4 seed mixture showed the highest dry matter mass with 3.41 grams, and with an NDVI value of 0.695, it was the third highest in a dead race together with the H4R4 seed mixture. The lowest dry matter weight was obtained by the H4R1 treatment with 2.86 grams, and the average seed yield of 3088 kg ha^{-1} was also the second lowest among the seed mixtures.

Results of Pearson's correlation test

Based on the Pearson's correlation test, there was a correlation of 0.476 between the NDVI value and the biomass, which is considered medium strength. There was a correlation between the NDVI value and seed yield at the level of 0.703, which is considered a strong correlation. There was a correlation of 0.606 between dry matter mass and seed yield, which is considered a medium strength correlation. Table 6 shows the results of the Pearson correlation test.

Table 4. Post-harvest grain moisture content %

Codes	Grain moisture content %
1/III	8.5
2/I	8.9
3/I	8.6
4/IV	8.3
5/II	8.6
6/III	8.7
7/II	8.3
8/I	9
9/II	9.1
10/IV	8.4
11/III	9
12/I	8.3
13/III	8.2
14/IV	8.5
15/IV	8.1
16/IV	8.5
17/III	8.5
18/IV	8.8
19/IV	8.6
20/II	8.7
21/III	8.4
22/IV	8.2
23/I	8.3
24/I	8.8
25/IV	9
26/I	8.6
27/IV	8.4
28/IV	8.3

Table 5. Summary table of average NDVI values, average biomass, average dry matter mass and average harvested seed yield in the rye-hairy vetch experiment sown in different seed ratios

Codes	Replicates	NDVI values	Biomass kg ha^{-1}	Dry material mass gram	Seed yield kg ha^{-1}
H1R1	4	0,64	25140	3,21	3386
H1R2	4	0,69	28550	3,26	4244
H1R3	4	0,68	25067	3,19	3943
H1R4	4	0,70	28200	3,26	4432
H2R1	4	0,65	24800	3,11	2926
H2R2	4	0,68	29800	3,37	3887
H2R3	4	0,69	30900	3,26	4137
H2R4	4	0,69	27400	3,24	4233
H3R1	4	0,65	25850	3,09	3235
H3R2	4	0,68	31200	2,91	3718
H3R3	4	0,70	26700	3,29	3808
H3R4	4	0,69	37,466	3,36	4105
H4R1	4	0,67	30990	2,86	3088
H4R2	4	0,69	25467	3,01	3246
H4R3	4	0,69	32950	3,26	4049
H4R4	4	0,70	36250	3,21	3990
H5R1	4	0,65	24867	3,24	3589
H5R2	4	0,67	30933	3,21	3624
H5R3	4	0,69	31467	3,16	3812
H5R4	4	0,70	28000	3,41	3935
H6R1	4	0,67	31650	3,04	3203
H6R2	4	0,68	25200	3,31	3868
H6R3	4	0,69	30400	3,19	4019
H6R4	4	0,69	33360	3,24	3827
H7R1	4	0,67	26200	3,16	3144
H7R2	4	0,68	27300	3,09	3756
H7R3	4	0,69	33000	3,31	3675
H7R4	4	0,69	30250	3,29	3787
Total	112	0,67	29263	3,20	3738

Table 6. The Pearson's correlation between the average NDVI value, average biomass, average dry matter weight and average harvested seed yield.

Results	Average of NDVI	Average of biomass	Average of dry material mass	Average of seed yield
Average of NDVI	1	0,476*	0,361	0,703**
Average of biomass	0,476*	1	0,113	0,328
Average of dry material mass	0,361	0,113	1	0,606**
Average of seed yield	0,703**	0,328	0,606**	1

****Correlation is significant at the 0.01 level (2-tailed), *. Correlation is significant at the 0.05 level (2-tailed).**

Discussion

The collection of biomass plant samples was preceded by three NDVI data collection. During the experiment, based on Pearson's correlation results, we established a medium-strength correlation between the NDVI values and the average biomass yield. Researchers established positive correlations between the cuted, measured biomass and the estimated vegetation indices (Frank and Karn, 2003; Fan *et al.*, 2009 and Swatantran *et al.*, 2011). In other research, a strong correlation between NDVI measurements and aboveground biomass was observed in durum wheat (*Triticum turgidum L. var. durum*) (Cabrera-Bosquet *et al.*, 2011).

In the case of forest trees in the Central Plain, the relationship between NDVI values and productivity indicators was investigated. In the research, the NDVI values showed a strong correlation between, among other things, the seed yield of the trees (Wang *et al.*, 2010). The unique and synergistic relationships between green canopy level, photosynthetically active radiation and normalized differential vegetation index (NDVI) measurements in soybean (*Glycine max* (L.) Merr) were investigated in North Dakota, USA, in relation to seed yield prediction. The best yield prediction measurement was the NDVI measurement performed at the beginning of seed development with a coefficient of determination of 0.65 (Schmitz and Kandel, 2021). During our research, we measured a strong correlation between average NDVI values and average seed yields using the Pearson's correlation test.

In Bangladesh, at the University of Agricultural Sciences in Mymensingh, research was conducted in the field experiment regarding the assessment of the growth parameters regulating the dry matter and seed yield of soybean (*Glycine max* (L.) Merr). The results show that high-yielding soybean genotypes should have a higher dry matter production capacity at all growth stages (Malek *et al.*, 2012). In Rennes, France, in 1992 and 1993, 15 horse bean (*Vicia faba* L.) genotypes were analysed for dry matter accumulation and seed yield in terms of average seed weight. The amount of accumulated dry matter at the

beginning of pod ripening served as a good early sign for determining the number of seeds per m^{-2} and the average seed weight. In the subsequent phenological stage, dry matter mass showed a significant and positive correlation with seed yield (Nachi and Guen, 1996). In our research, also according to Pearson's correlation, there was a medium level correlation between the dry matter weight and the average seed yield, and the H3R4 seed mixture can also be mentioned as an example, which was outstanding in terms of dry matter weight (3.36 grams) and seed yield (4104 kg ha^{-1}) and was not statistically different from the best performing seed mixtures in these indicators.

CONCLUSION

During the research, we established that the highest proportion of rye used in the seed mixtures (R4= 80 kg ha^{-1}) resulted in the highest values in the measured parameters (average NDVI, average biomass, average dry matter weight, average seed yield). The highest average NDVI value was obtained by sowing the H1R4 seed mixture (0.701), and also the highest seed yield with 4432 kg ha^{-1}. The H3R4 seed mixture yielded the most biomass with 37,466 kg ha^{-1}. The highest dry matter mass was obtained by sowing the H5R4 seed mixture with 3.41 grams. During the post-harvest crop monitoring, it could be seen that the rye suppressed the hairy vetch for the harvesting time, so there were hardly any vetch seeds in the harvested seed quantity. Accordingly, the smallest amount of rye used in the seed mixtures (R1= 20 kg ha^{-1}) resulted in the smallest value in the measured parameters (average NDVI, average biomass, average dry matter weight, average seed yield). The smallest average NDVI value of 0.643 was obtained by sowing the H1R1 seed mixture. The smallest amount of average biomass was obtained by sowing the H2R1 seed mixture with 24,800 kg ha^{-1}, and this seed mixture had the smallest average seed yield of 2,926 kg ha^{-1}. The lowest dry matter mass was obtained by the H4R1 seed mixture with 2.86 grams. Based on the Pearson's correlation test, there was a positive correlation between the average NDVI value and the average biomass at a medium level, and between the average NDVI value and the average seed yield at a significant level. There was a positive correlation between dry matter mass and seed yield at a moderate level. In the future, it may be worthwhile to expand the experiment and use clean sowings, as well as to further expand the amount of seeds in the mixture.

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NEMZETI KUTATÁSI FEJLESZTÉSI ÉS INNOVÁCIÓS HIVATAL

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تأثير معدلات خلط التقاوي لكل من نبات الراي والبيقية المشعرة على إنتاجية نبات الراى

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الملخص

أجريت تجربة بمعهد بحوث نيريغهازا، جامعة ديبريسن، المجر خلال الموسم الشتوى ٢٠٢١. هدفت هذه الدراسة إلى معرفة تأثير خلط معدلات تقاوي نباتات الراى والبيقية المشعرة على إنتاجية نباتات الراى. اشتملت التجربة على أربع معدلات تقاوي من نبات الراى (٢٠، ٤٠، ٦٠ و٨٠ كجم/هكتار) وسبعة معدلات من البيقية المشعرة (٢٠، ٣٠، ٤٠، ٥٠، ٦٠، ٧٠، ٨٠ كجم/هكتار)، استخدم تصميم القطاعات الكاملة العشوائية في أربع مكررات. أظهرت النتائج أن خليط معدل التقاوي ٨٠ كجم/هكتار من تقاوي الراى + ٢٠ كجم/هكتار من تقاوي البيقية المشعرة سجل أعلى قيمة لمتوسط مؤشر الغطاء النباتي التفاضلي الطبيعي (NDVI) (0.701) وأعلى محصول بذور لنباتات الراى (٤٤٣٢ كجم/هكتار). تم الحصول على أعلى محصول بيولوجي (٣٧٤٦٦ كجم/هكتار) نتيجة استخدام ٨٠ كجم/هكتار من تقاوي الراى + ٤٠ كجم/هكتار من تقاوي البيقية المشعرة. أعطى خليط البذور ٨٠ كجم/هكتار من تقاوي الراى + ٦٠ كجم/هكتار من تقاوي البيقية المشعرة أعلى قيمة للمادة الجافة (٣,٤١ جرام)، على الجانب الآخر سجل خليط التقاوي ٢٠ كجم/هكتار من تقاوي الراى + ٢٠ كجم/هكتار من تقاوي البيقية المشعرة أقل قيمة NDVI، كما سجل خليط التقاوي ٢٠ كجم/هكتار من تقاوى الراى + ٣٠ كجم/هكتار من تقاوى البيقية المشعرة أقل قيمة للمحصول البيولوجي (٢٤٨٠٠ كجم/هكتار) وأقل كمية من محصول البذور/هكتار. سجل خليط التقاوي ٢٠ كجم/هكتار من بذور الراى + 50 كجم/هكتار من بذور البيقية المشعرة أقل وزن للمادة الجافة (٢,٨٦ جرام) ، أظهرت النتائج المتحصل عليها وجود ارتباط معنوي موجب قدره ٠,٤٧٦ بين متوسط (NDVI) والمحصول البيولوجي، كما كان هناك ارتباط معنوي موجب قدره ٠,٧٠٣ بين قيم (NDVI) ومحصول البذور/هكتار، كذلك وجد ارتباط معنوى موجب قدرة ٠,٦٠٦ بين محصول المادة الجافة ومحصول البذور/هكتار.