Ukrainian Journal of Ecology

Ukrainian Journal of Ecology, 2021, 11(8), 128-133, doi: 10.15421/2021_279

ORIGINAL ARTICLE

Influence of seeding rate and growth regulator "Vermiyodis" on photosynthetic and seed productivity of winter rape

I. Sendetskyi*, M. Bakhmat, V. Sendetskyi, I. Shuvar

State Agrarian and Engineering University in Podilia, Kamyanets-Podilsky, Ukraine

**Corresponding author E-mail: Sendetsky.ivan@gmail.com, vermos2011@ukr.net*

Received: 23.09.2021. Accepted: 19.10.2021.

The purpose is to investigate the effect of seeding rates of growth regulator "Vermiyodis" with different methods of application on the formation of photosynthetic and seed productivity of winter rape Cheremosh and Mercedes hybrid in the Western Forest-Steppe. Methods are field, analytical and statistical. Results: Studies have shown that pre-sowing treatment of winter rape seeds by single and double spraying of plants during the growing season at different seeding rates significantly improved the photosynthetic and seed productivity of winter rape. It was found that the highest yield of winter rape Cheremosh was obtained in the sowing variant of 0.8 million/ha of sprouting seeds by pre-sowing treatment of seeds with growth regulator "Vermiyodis" and double spraying with the same agent. It averaged 4.24 t/ha over the years of research, which is 0.63 t/ha higher than the control indicator and 0.33 t/ha of similar variants at seeding rates of 0.6 million/ha and 0.47 t/ha at seeding rates of 1.0 million/ha of sprouting seeds. On the same variant of fertilizer, on average over the years of research, the highest yield of winter rape hybrid Mercedes was obtained-4.13 t/ha (+0.61 t/ha compared to control) at seeding rates of 0.6 million/ha of sprouting seeds, which is more by: 17.3% compared to the control; by 17.0%-at seeding rates of 0.8 million/ha of sprouting seeds; by 15.1%-at seeding rates of 1.0 million/ha of sprouting seeds.

Keywords: Winter rape, Photosynthesis, Leaf surface area, Seeding rates, Growth regulator, Yield.

Introduction

Rape is a highly productive oil crop used in food and feed production, is a raw material for industry and a source of bioenergy. Unlike other export-oriented crops, primarily sunflower, rape improves the agrophysical properties and phytosanitary condition of the soil and is a valuable ecological precursor for winter cereals (Haydash V.D., et al., 1986, Kuznetsova R.Y., 1975, Soroka V.I., 2012).

Soil and climatic conditions of Ukraine are favorable for normal growth and development of winter rape plants and meet its biological requirements. With the alternation of crop rotations and the application of the necessary agro-technological measures for growing this crop, you can get a yield of 4-5 t/ha (Vlashchuk A.M., et al., 2016, Lykhochvar V.V., et al., 2014, Shpaar D., 2007). This productivity corresponds to the majority of registered in the State Register of domestic and foreign varieties and hybrids of winter rape, but in recent years its yield in many farms does not exceed 1.7-2.8 t/ha. Thus, in 2018 in Ukraine from an area of 1 million hectares only 2.61 t/ha of seeds were collected (Svydynyuk I., 2018).

It is known from the literature that high-yielding seeds are formed under optimal growing conditions, among which seeding rates, sowing methods, nutrition backgrounds, as well as treatment of seed with biostimulants, trace elements and other agents play an important role (Shapar L., 2014). The rational limit of crop thickening or liquefaction for many crops has not yet been determined, despite a long period of research on this issue. For normal growth and development of plants requires an adequate area of nutrition, at which they will have sufficient nutrients and moisture to create the necessary vegetative mass and seed formation. After all, it is known that the yield decreases with both sparse and thickened stems (Klymenko I. I., 2015, Svydynyuk I., 2018).

Thus, seeding rates are the main component of rapeseed cultivation technology. Given the biological characteristics of varieties and hybrids, as well as changes in climatic conditions, the study of seeding rates of winter rape in the Western Forest-Steppe of Ukraine is relevant (Lavrynenko Y.O., et al. 2016, Svydynyuk I., 2018).

Scientific and practical interest in plant growth and development regulators is growing in many countries around the world. Their use in crop production, horticulture and forestry gives results that can not be achieved by other methods and becomes one of the main reserves for increasing crop yields (Anishyn L.A. 2002, Ponomarenko S.P., 2003).

Analysis of the literature shows that the widespread use of regulators in agriculture is given much attention in most economically developed countries: France, Britain, Germany, Switzerland, Japan, China and others, and in recent years in Ukraine (Bilityuk A.P., 2000, Kvashchuk O.V., et al., 1999, Ponomarenko S.P., 2003).

In recent years, significant progress in the development and production of humic plant growth regulators has been achieved by scientists of the Bioconversion Association. They created a group of very effective environmentally friendly agents that affect the course of physiological and biochemical processes in plants, developed a technology for biostimulators of plant growth "Vermistim", "Vermimag", "Vermiyodis" and organized their production in PE "Bioconversion" (Ivano -Frankivsk) (Melnyk I.P., 2015).

"Vermiyodis" is produced on the basis of organic fertilizer "Vermimag", which is made by hydrodynamic cavitation from organic fertilizer "Biohumus" using special equipment, adding an aqueous solution of biologically active iodine of the appropriate concentration.

"Vermiyodis" increases the germination and energy of seed germination, stimulates the creation of a strong root system, promotes rapid rooting of cuttings, stimulates plant growth and development and increases plant immunity to diseases and pests, improves photosynthetic activity of plants, reduces heavy metals and radionuclides in plants, active accumulation of sugar, protein and vitamins in vegetables and fruits, increases yields and product quality. It can be used on a variety of plant objects and stages of plant development, unlike many plant growth regulators, whose range of use is many times narrower.

From the above review of the literature we can conclude that in many countries and in Ukraine, science and practice have sought ways to increase yields and quality of crops, reduce the negative impact of toxic substances on agricultural systems and one of the areas was the use of plant growth regulators based on humic acids, in technologies of cultivation of agricultural crops.

Given the fact that for the conditions of the Western Forest-Steppe research in this area is insufficient, we studied the methods of application of the growth regulator "Vermiyodis" and determined the optimal seeding rates of winter rape in cultivation technologies.

Materials and Methods

The studies were performed during 2017-2020 on sod-podzolic soils of the experimental field of the Carpathian State Agricultural Research Station ISG of the Carpathian region of NAAS, which contain 2.8-3.0% humus, 77-82 mg/kg of alkaline hydrolyzed nitrogen, 113-120 mg/kg of mobile phosphorus, 132-138 mg/kg of exchangeable potassium, pH-5.5-5.9.

Agricultural techniques, in addition to the studied factors, are generally accepted for the region. We studied seeding rates of winter rape (0.6 million/ha; 0.8 million/ha; 1.0 million/ha) and methods of application of the plant growth regulator "Vermiyodis": pre-sowing seed treatment-5 l/t; single spraying-4 l/ha; double spraying of plants during the growing season-4 l/ha.

The source material for the research was the seeds of winter rape Cheremosh and a hybrid of Mercedes. Field experiments are laid down in four repetitions according to the method of research (Dospekhov B.A., 1985, Nychyporovych A.A., 1965).

Results

Photosynthesis is the most important biochemical process of plant life, as a result of which they absorb the energy of solar radiation and with its help synthesize organic matter from inorganic substances. Its intensity is influenced by a number of factors: the characteristics of the variety, its growing season, as well as environmental conditions, technological measures for crop care (Nychyporovych A.A., 1965). Important indicators of photosynthetic activity are leaf surface area, photosynthetic potential and net photosynthesis productivity. The formation of the leaf surface area is a prerequisite for obtaining maximum crop yields. Theoretical substantiation of different food areas was made by many researchers, in particular F.M. Kuperman, I.I. Syniachin and others. V.F. Coerman established the relationship between the phases of ontogenesis of plants and the density of their placement per unit area of sowing (Kuperman F.M., 1977, Matsera O.O., 2017).

Based on the analysis of modern publications, it follows that growth regulators have a direct effect on the intensity of photosynthesis, creating conditions for accelerated growth and development of crops and increased yields (Lavrynenko Y.O., et al., 2016, Chykov V.Y., 1987).

According to the results of the study (2017-2020) we found that pre-sowing treatment of winter rape Cheremosh with growth regulator "Vermiyodis" (5 l/t) by single and double spraying of plants during the growing season with growth regulator "Vermiyodis" at seeding rates 0.6, 0.8, 1.0 million/ha of sprouting seeds during the whole period of culture vegetation had a significant influence on the formation of the assimilation surface area. The area of the leaves increased depending on the phase of development of rape plants. At the beginning of the growing season, it grew slowly, reached its maximum during the flowering phase, and then decreased again (Table 1).

Table 1. Leaf surface area of winter rape plants Cheremosh variety depending on the seeding rate and application method of growth regulator (average for 2018-2020), thousand m^2/ha.

Variant of the experiment	Development phase of winter rape Cheremosh variety								
	Stalking			Budding			Flowering		
	seeding rate, million/ha of sprouting seeds								
	0.6	0.8	1.0	0.6	0.8	1.0	0.6	0.8	1.0
1	10.0	10.5	9.8	15.7	16.4	15.3	34.0	34.5	33.7
2	11.7	12.4	11.4	19.2	20.1	19.1	38.8	39.1	36.6
3	12.1	12.9	11.4	19.3	21.2	19.4	39.6	40.3	39.5
4	12.3	13.3	12.6	20.5	21.5	20.8	40.7	42.7	41.2
5	13.0	13.9	12.8	20.6	21.7	20.8	40.9	43.1	40.9
6	13.4	14.0	13.3	21.4	22.7	21.1	41.7	43.9	41.4
LSD_{05}	0.94	0.98	0.92	1.48	1.56	1.45	3.05	3.14	3.01

Experiment variant: 1-control; 2-pre-sowing treatment "Vermiyodis" (5 l/t); 3-one-time spraying "Vermiyodis" (4 l/ha); 4-pre-sowing treatment (5 l/t) and one-time spraying "Vermiyodis" (4 l/ha); 5-double spraying "Vermiyodis" (4 l/ha); 6-pre-sowing treatment (5 l/t) and double spraying "Vermiyodis" (4 l/ha).

In the variant of pre-sowing treatment of Cheremosh seeds with the growth regulator "Vermiyodis" (5 l/t) and its double spraying during the growing season of 4 l/ha at seeding rates of 0.8 million/ha of sprouting seeds leaf area in the stalking phase over the years was on average-14.0 thousand m^2/ha, in the budding phase-22.7 thousand m^2/ha, in the flowering phase-43.0 thousand m^2/ha, which, respectively, by 3.5 thousand m^2/ha, 6.3 thousand m^2/ha and 9.4 thousand m^2/ha more compared to the control.

It was also found that during the entire growing season, depending on the method of application of the growth regulator "Vermiyodis" and seeding rate, the formation intensity of the assimilation surface area of winter rape plants hybrid Mercedes increased (Table 2).

Based on the results of determining the leaf area of winter rape plants hybrid Mercedes, it was found that the application methods of the growth regulator "Vermiyodis" in all phases of plant growth and development depending on the seeding rate provided an increase in leaf area of crops.

The largest leaf area of rape plants of the winter hybrid Mercedes was formed in the variant of pre-sowing seed treatment with growth regulator "Vermiyodis" at a dose of 5 l/t and double spraying of rape plants with growth regulator "Vermiyodis" at 4 l/ha at seeding rates of 0.6 million/ha of sprouting seeds: in the stalking phase-14.8 thousand m^2/ha, or 3.0 thousand m^2/ha more control, in the budding phase-22.5 thousand m^2/ha, or 5.9 thousand. m^2/ha more and in the flowering phase-43.7 thousand m^2/ha, or 7.0 thousand m^2/ha more.

Table 2. Leaf area of winter rape plants Mercedes variety, depending on the seeding rate and method of application of the growth regulator "Vermiyodis" (average for 2018-2020), thousand m^2/ha.

Variant of the experiment	Development phase of winter rape Mercedes variety								
	Stalking			Budding			Flowering		
	seeding rate, million/ha of sprouting seeds								
	0.6	0.8	1.0	0.6	0.8	1.0	0.6	0.8	1.0
1	11.8	11.0	11.0	16.6	15.8	15.1	36.7	35.0	33.4
2	12.9	12.5	12.5	20.0	19.2	18.8	39.4	38.8	37.4
3	13.0	13.0	12.6	20.4	19.8	18.6	42.3	39.8	38.3
4	13.5	13.1	13.0	21.4	20.8	19.9	42.5	40.9	39.7
5	13.5	13.4	13.2	21.5	20.2	19.8	40.4	39.9	40.2
6	14.8	13.7	13.4	22.5	21.6	21.6	43.7	42.6	41.8
LSD_{05}	1.07	0.98	0.94	1.56	1.49	1.47	3.22	3.08	3.01

Experiment variant: 1-control; 2-pre-sowing treatment "Vermiyodis" (5 l/t); 3-one-time spraying "Vermiyodis" (4 l/ha); 4-pre-sowing treatment (5 l/t) and one-time spraying "Vermiyodis" (4 l/ha); 5-double spraying "Vermiyodis" (4 l/ha); 6-pre-sowing treatment (5 l/t) and double spraying "Vermiyodis" (4 l/ha)

It was researched that in the variants where pre-sowing treatment of seeds with growth regulator "Vermiyodis" (5 l/t) and double spraying of winter rape plants during the growing season was used, the photosynthetic potential in the germination-wax ripeness phase was winter rape Cheremosh 2,667 million m^2 days/ha, which is 0.407 million m^2 days/ha higher than the seeding rate of 0.8 million/ha, the Mercedes hybrid has 2,612 million m^2 days/ha, which is 0.367 million m^2 days/ha higher control over seeding rates of 0.6 million/ha of sprouting seeds.

Studies have shown that the methods of application of the growth regulator "Vermiyodis" and seeding rates affected the yield of winter rape Cheremosh (Table 3).

Studies conducted during 2018-2020 found that the pre-sowing treatment of seeds and single or double spraying of plants with growth regulator "Vermiyodis" the highest yield of winter rape Cheremosh variety was obtained at seeding rates of 0.8 million/ha of sprouting seeds.

Thus, in the variant of pre-sowing treatment of seeds with growth regulator "Vermiyodis" and double spraying during the growing season of plants with the same growth regulator, the yield averaged 4.24 t/ha, or 0.63 t/ha higher than the control, and it was 0.33 t/ha higher than in the sprouting variant at seeding rates of 0.6 million/ha and 0.47 t/ha-at seeding rates of 1.0 million/ha of sprouting seeds.

Table 3. Yield of winter rape Cheremosh variety, depending on the seeding rate and method of application of growth regulator "Vermiyodis", t/ha (average for 2018-2020).

Variant of the Experiment	Yeild, T/Ha					
	Year			Average For 3 Years	+Before Control	
	2018	2019	2020		T/Ha	%
	Seeding Rate 0.6 Mln/Ha					
1	3.52	3.02	3.48	3.34	-	-
2	3.78	3.23	3.79	3.60	0.26	7.8
3	3.83	3.25	3.78	3.62	0.28	8.4

4	3.96	3.31	3.92	3.73	0.39	11.7
5	4.03	3.37	4.06	3.82	0.48	14.4
6	4.12	3.48	4.13	3.91	0.57	17.1
Seeding Rate 0.8 mln/ha						
1	3.76	3.24	3.83	3.61	-	-
2	4.08	3.53	4.17	3.92	0.31	8.6
3	4.12	3.59	4.11	3.94	0.33	9.1
4	4.25	3.72	4.24	4.07	0.46	12.7
5	4.34	3.83	4.28	4.15	0.54	15.6
6	4.43	3.90	4.39	4.24	0.63	17.5
Seeding Rate 1.0 mln/ha						
1	3.31	2.86	3.52	3.23	-	-
2	3.58	3.12	3.68	3.46	0.23	7.1
3	3.61	3.16	3.67	3.48	0.25	7.7
4	3.70	3.20	3.96	3.62	0.39	12.1
5	3.75	3.28	4.01	3.68	0.45	13.9
6	3.86	3.35	4.10	3.77	0.50	16.7
LSD_{05} Factor A (seeding rate)	0.10	0.08	0.12			
LSD_{05} Factor B (application of growth regulator)	0.07	0.09	0.10			

Experiment variant: 1-control; 2-pre-sowing treatment "Vermiyodis" (5 l/t); 3-one-time spraying "Vermiyodis" (4 l/ha); 4-pre-sowing treatment (5 l/t) and one-time spraying "Vermiyodis" (4 l/ha); 5-double spraying "Vermiyodis" (4 l/ha); 6-pre-sowing treatment (5 l/t) and double spraying "Vermiyodis" (4 l/ha).

Pre-sowing seed treatment, single and double spraying of plants during the growing season and seeding rates contributed to increasing the yield of winter rape hybrid Mercedes (Table 4).

Table 4. Yield of winter rape hybrid Mercedes depending on the seeding rate and method of application of the growth regulator "Vermiyodis", t/ha (average for 2018-2020).

Variant of the experiment	**Yeild, t/ha**				**+Before control**	
	Year			**Average**		
	2018	**2019**	**2020**	**for 3 years**	**t/ha**	**%**
Seeding rate 0.6 mln/ha						
1	3.47	3.50	3.59	3.52	-	-
2	3.71	3.82	3.87	3.80	0.28	8.0
3	3.79	3.85	3.96	3.83	0.31	8.8
4	3.90	3.93	4.02	3.95	0.45	12.2
5	3.96	4.01	4.10	4.02	0.58	14.2
6	4.05	4.12	4.22	4.13	0.61	17.3
Seeding Rate 0.8 mln/ha						
1	3.23	3.31	3.18	3.24	-	-
2	3.46	3.58	3.37	3.47	0.23	7.1
3	3.50	3.62	3.41	3.51	0.27	8.3
4	3.61	3.70	3.49	3.62	0.38	11.7
5	3.65	3.75	3.64	3.68	0.44	13.6
6	3.74	3.85	3.78	3.79	0.55	17.0
Seeding Rate 1.0 mln/ha						
1	3.08	3.20	3.05	3.11	-	-
2	3.31	3.40	3.25	3.32	0.21	6.8
3	3.34	3.51	3.20	3.35	0.24	7.7
4	3.42	3.58	3.36	3.39	0.35	10.9
5	3.46	3.60	3.50	3.52	0.41	13.1
6	3.52	3.63	3.59	3.58	0.47	15.1
LSD_{05} Factor A (seeding rate)	0.05	0.08	0.10			
LSD_{05} Factor B (application of growth regulator)	0.07	0.06	0.08			

Experiment variant: 1-control; 2-pre-sowing treatment "Vermiyodis" (5 l/t); 3-one-time spraying "Vermiyodis" (4 l/ha); 4-pre-sowing treatment (5 l/t) and one-time spraying "Vermiyodis" (4 l/ha); 5-double spraying "Vermiyodis" (4 l/ha); 6-pre-sowing treatment (5 l/t) and double spraying "Vermiyodis" (4 l/ha).

Studies have shown that pre-sowing treatment of winter rape seeds hybrid Mercedes with growth regulator "Vermiyodis" at a dose of 5 l/ha at seeding rates of 0.6 million/ha of sprouting seeds provided an increase in yield by an average of 8% compared to

control, at seeding rates of 0.8 million/ha of sprouting seeds, respectively, by 7.4% more, at seeding rates of 1.0 million/ha of sprouting seeds-by 6.8%.

One-time spraying of winter rape plants during the growing season with the growth regulator "Vermiyodis" at a dose of 4 l/ha at seeding rates of 0.6 million/ha of sprouting seeds provided an increase in yield of winter rape by 8.8% compared to control, at seeding rates 0, 8 million/ha of sprouting seeds-by 8.3%, at seeding rates of 1.0 million/ha-by 7.7%.

Pre-sowing treatment of winter rape with the growth regulator "Vermiyodis" at a dose of 5 l/t in combination with a single spraying of plants during the growing season "Vermiyodis" (4 l/ha) and at seeding rates of 0.6 million/ha of sprouting seeds provided an increase in seed yield by 12.2 % compared to the control, for seeding rates of 0.8 million/ha-by 11.7%, for seeding rates of 1.0 million/ha-by 10.9%.

In the variant of double spraying of winter rape plants during the growing season with the growth regulator "Vermiyodis" (4 l/ha) and seeding rate of 0.6 million/ha of sprouting seeds contributed to an increase in yield of winter rape by 14.2% compared to the control, according to seeding rates 0.8 million/ha of sprouting seeds-by 13.6%, at seeding rates of 1.0 million/ha of sprouting seeds-by 13.1%.

Pre-sowing treatment of winter rape seeds hybrid Mercedes with growth regulator "Vermiyodis" in combination with double spraying at seeding rates of 0.6 million/ha of sprouting seeds provided an increase in yield by 17.3% compared to control, at seeding rates of 0.8 million/ha of sprouting seeds-by 17.0%, at seeding rates of 1.0 million/ha of sprouting seeds-by 15.1%.

Thus, the highest yield of winter rape seeds hybrid Mercedes-4.13 t/ha (+0.61 t/ha compared to control) on average for 2018-2020 was obtained in the variant for pre-sowing treatment of winter rape with growth regulator "Vermiyodis" at a dose of 5 l/t, seeding rates of 0.6 million/ha of sprouting seeds and double spraying of plants during the growing season with the growth regulator "Vermiyodis" at a dose of 4 l/ha.

Conclusion

Based on the research, it can be concluded that both factors studied in the study (seeding rate and application of growth regulator) have a significant impact on the formation of the yield of winter rape Cheremosh and Mercedes hybrids.

It was found that in the variant where pre-sowing treatment of winter rape varieties Cheremosh with growth regulator "Vermiyodis" (5 l/t) and double application during the growing season of 4 l/ha at seeding rates of 0.8 million/ha of sprouting seeds in the stalk growth phase leaf surface area in the stalk phase of the crop for the years of study averaged-14.0 thousand m^2/ha, in the budding phase-22.7 thousand m^2/ha in the flowering phase-43.9 thousand m^2/ha, which, respectively, by 3.5 thousand m^2/ha, 6.3 thousand m^2/ha and 9.4 thousand m^2/ha more compared to the controls. In these variants, the largest leaf surface of rape plants of the winter hybrid Mercedes in the stalking phase was 14.8 thousand m^2/ha or 3.0 thousand m^2/ha more control, in the budding phase 22.5 thousand m^2/ha or 5.9 thousand m^2/ha more control and in the flowering phase 43.7 thousand m^2/ha or 7.0 thousand m^2/ha more control over the seeding rates of 0.6 million/ha of sprouting seeds.

It was investigated that in the variants where pre-sowing treatment of seeds with growth regulator "Vermiyodis" (5 l/t) was used and double spraying of winter rape plants during the growing season was carried out, the photosynthetic potential in the germination-wax ripeness phase of Cheremosh variety was 2.677 million m^2 days/ha, which is 0.407 million m2 days/ha more than the seeding rate of 0.8 million/ha, the Mercedes hybrid has 2.612 million m^2 days/ha, which is 0.367 million m^2 days/ha more than the control at seeding rates of 0.6 million/ha of sprouting seeds.

Studies have shown that the pre-sowing treatment of seeds and single or double spraying of plants with growth regulator "Vermiyodis" the highest yield of winter rape Cheremosh was obtained at seeding rates of 0.8 million/ha of sprouting seeds. Thus, in the variant of pre-sowing treatment of seeds with growth regulator "Vermiyodis" and double spraying during the growing season of plants with the same growth regulator, the yield averaged 4.24 t/ha, or 0.63 t/ha higher than the control, and it was 0.33 t/ha higher than in the similar variant at seeding rates of 0.6 million/ha and 0.47 t/ha-at seeding rates of 1.0 million/ha of sprouting seeds.

The highest yield of winter rape hybrid Mercedes-4.13 t/ha (+0.61 t/ha compared to the control) on average over the years of research was obtained in the variant of pre-sowing treatment of winter rape with growth regulator "Vermiyodis" at a dose of 5 l/t, seeding rates of 0.6 million/ha of sprouting seeds and double spraying of plants during the growing season with the growth regulator "Vermiyodis" at a dose of 4 l/ha.

References

Anishyn, L.A. (2002). Rehulyatory rostu roslyn: sumnivy i fakty. zh. Propozytsiya, 5:64-65.

Bilityuk, A.P. (2000). Rehulyatory rostu u formuvanni vrozhaynosti. Zakhyst roslyn, 10:21-23.

Vlashchuk, A.M., Shapar', L.V., Pryshchepo, M.M., Kolpakova, A.S. (2016). Urozhaynist' sortiv ripaku ozymoho zalezhno vid elementiv tekhnolohiyi v umovakh Pivdennoho Stepu Ukrayiny. Vseukrayins'ka naukovo-praktychna konferentsiya molodykh vchenykh i spetsialistiv 25-26 travnya. Dnipropetrovs'k, pp:50-51

Haydash, V.D., Koval'chuk, H.M., Dem"yanchuk, H.T. (1986). Ripak kul'tura velykykh mozhlyvostey. Uzhhorod: Karpaty, p:62.

Dospekhov, B.A. (1985). Metodyka polevoho opyta (s osnovamy statystycheskoy obrabotky rezul'tatov yssledovanyy)–3-e yzd., pererab. y dop. M. : Kolos, p:336.

Mel'nyk, I.P., Kolisnyk, N.M., Shuvar, I.A., Sendets'kyy, V.M., Titov ta in, I. M. (2015). Doshchovi cherv"yaky: naukovi aspekty vyroshchuvannya i praktychne zastosuvannya. Ivano-Frankivs'k : Symfoniya forte, p:444.

Kvashchuk, O.V., Bureyko, O.L., Bil', L.I. (1999). Vplyv rehulyatora rostu «Vermystym» na urozhaynist' ta pol'ovu skhozhist' sil's'kohospodars'kykh kul'tur. Biokonversiya orhanichnykh vidkhodiv i okhorona navkolyshn'oho seredovyshcha: tezy dopovidey V mizhnarodnoho konhresu.-Ivano-Frankivs'k: Play, p:56.

Klymenko, I.I. (2015). Vplyv rehulyatoriv rostu roslyn i mikrodobryva na urozhaynist' nasinnya liniy ta hibrydiv sonyashnyku. Selektsiya i nasinnytstvo. Vypusk 107:183-188.

Kuznetsova, R.YA. (1975). Raps–vysokourozhaynaya kul'tura. L.:Kolos, p:83.

Kuperman, F.M. (1977). Morfofyzyolohyya rastenyy. M.: Vysshaya Shkola, p:288.

Lavrynenko, YU.O., Vlashchuk, A.M., Shapar, L.V., Zheltova, A.H. (2016). Urozhaynist' kondytsiynoho nasinnya sortiv ripaku ozymoho zalezhno vid strukturnykh pokaznykiv ta vplyvu strokiv sivby i norm vysivu. Zroshuvane Zemlerobstvo, 66:102-111.

Lykhochvar, V.V., Buchyns'kyy, I.M. (2014). Systema udobrennya ripaku–zh. Ahrobiznes s'ohodni 13:18-21.

Matsera, O.O. (2017). Formuvannya ploshchi lystovoyi poverkhni ta fotosyntetychnoho potentsialu roslyn ozymoho ripaku zalezhno vid stroku posivu ta systemy udobrennya. Zbirnyk naukovykh prats' VNAU: Sil's'ke hospodarstvo ta lisivnytstvo, 6:55-62.

Metodyka polevykh opytov po yzuchenyyu ahrotekhnycheskykh pryemov vozdelyvanyya maslychnykh kul'tur. Metodycheskye rekomendatsyy. Ynstytut maslychnykh kul'tur. (2005). Zaporozh'e, p:16.

Nychyporovych, A.A. (1970). Nekotorye pryntsypy kompleksnoy optymyzatsyy fotosyntetycheskoy deyatel'nosty y produktyvnosty rastenyy. Vazhneyshye problemy fotosynteza v rastenyevodstve. M.: Yzd. AN SSSR, p:6-22.

Nychyporovych, A.A. (1965). Fotosyntez y voprosy yntensyfykatsyy sel'skoho khozyaystva. M.: Nauka, p:47.

Ponomarenko, S.P. (2003). Rehulyatory rostu roslyn. K., p:219.

Svydynyuk, I. (2018). Optymal'na shchil'nist' steblostoyu./Ahrobiznes s'ohodni, 11:62-65.

Soroka, V.I. (2012). Perspektyvy ripaku v Ukrayini. Ahronom, 2:86.

Lavrynenko, YU.O., Vlashchuk, A.M., Pryshchepo, M.M., Shapar, L.V. (2016). Formuvannya fotosyntetychnoho potentsialu u sortiv ripaku ozymoho zalezhno vid strokiv sivby ta normy vysivu. Zroshuvane zemlerobstvo, 65:75-80.

Chykov, V.Y. (1987). Fotosyntez y transport assymylyatov. M.: Nauka, P:185.

Shapar, L. (2014). Zvit pro naukovo-doslidnu robotu. Teoretychni osnovy selektsiyi sortiv i hibrydiv oliynykh kul'tur, naukovo-metodychni zasady nasinnytstva ta tekhnolohiyi yikh vyrobnytstva. Rozdil Kherson, pp:17-21.

Shpaar, D. (2007). Raps y surepytsa. Vyrashchyvanye, uborka, yspol'zovanye, p:320.

Citation:

Sendetskyi, I., Bakhmat, M., Sendetskyi, V., Shuvar, I. (2021). Influence of seeding rate and growth regulator "Vermiyodis" on photosynthetic and seed productivity of winter rape. *Ukrainian Journal of Ecology* 11 (8), 128-133.