THE CHLOROPHYLL AND OIL CONTENT OF MUSTARD DEPENDING ON THE USE OF GROWTH REGULATORS WITH ANTI- STRESS ACTION IN THE FOREST STEPPE OF UKRAINE

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Introduction. Mustard is an annual herb of the family *Brassicaceae* and is an important cash crop. *Brassica* includes many crop species that provide edible roots, leaves, stems, buds, flowers and seeds. The seeds and whole grass are used for medicinal purposes, which can reduce phlegm and relieve asthma; mustard can also be used as an excellent honey plant. Mustard is very rich in nutrients and contains a large amount of carotene, potassium, calcium and vitamins. Mustard seed flour is called mustard and is a seasoning (Shekhawat, Rathore, Premi, Kandpal, Chauhan, 2012).

On the other hand, mustard is not only an important fresh vegetable, but also an important agricultural and sideline processing product. Mustard plants are similar to canola in many places, for example, they look like canola, and they are stronger than canola when growing in dry conditions or when exposed to disease. Therefore, mustard is the preferred candidate material to replace rape. Mustard also has a special fragrance, which can increase appetite and help digestion; it also has the health care function of clearing heat and detoxification, antibacterial and detumescence. Mustard has a unique effect on the treatment of blood disorders (Meng Qiufeng, Wang Yuhong, Ren Xiliang, et al., 2006).

Oilseed crops require adequate availability of fertilizers for maximum productivity (Kazemeini, Edalat, Shekoofa, Hamidi, 2010). Nitrogen (N_2), phosphorous (K_2O_5), and potassium (K_2O) (NPK) fertilizers increase crop yield capacity by influencing plant height, the number of flowering/fruiting branches, total plant weight, leaf area index, as well as the number and weight of siliquae and seeds per plant (Siadat, S.A., Sadeghipour, O., Hashemi-dezfouli A. H., 2010. Within the whole growth period of mustard, nitrogen fertilizer was the most needed, followed by potassium and phosphorus. Mustard fertilization should follow the principle of base fertilizer first and top-dressing second. Ternary compound fertilizer (19:19:19) 50 kg/667m^2, spread on the ground is ploughed into the soil.

The application of nitrogen fertilizers substantially increased the seed yield capacity even under diverse and contradicting conditions. Plant height increased with the decrease in planting space and the use of nitrogen fertilizer Mobasser *et al*. Nitrogen rates of 135 and 150 kg ha^{-1} significantly increased harvest index (HI) Kazemeini *et al*. (2010), while it remained unaffected (Danesh-shahraki *et al*., 2008, Rathke G.W., Behrens, T, and Diepenbrock, W., 2006. The 1000-seed weight remained unaffected at various levels of NPK Singh *et al*., (2017) . Rathke *et al*. (2006) reported that fertilizer N rate strongly

influenced rape productivity. They found that rape yield was influenced by various application rates of N fertilizer (Almi, Jannah., 2019). Plant growth compound regulator (PGR) shows prominent effects on plant metabolism, resistance, growth, and productivity (Fang-bo et al., 2017; Rademacher 2015).

Temperature and relative humidity are seemingly the two environmental factors that most immediately influence the performance of foliar nutrients. Besides, the temperature can affect foliar absorption by way of its effect on the drying rate of the applied nutrient spray, the physic chemistry of nutrient solution, as well as its effect on leaf cuticles, and the plant metabolism, ion uptake, and assimilation (Demirer, Ozer, Kocturk, 2004; Melnik, Zherdetska, Ali, Romanko, Makarchuk, Akuaku, 2015). An instant effect of high temperature is reported to increase the drying rate of the spray droplets, which directly diminishes absorption. The ineffectiveness of the applied foliar fertilizers in our research could partly be due to the faster rate of evaporation of the spray solutions deposited onto the leaves. Besides, the temperature seems to directly affect the rate of leaf development and such a way to influence the foliar absorption through effects on leaf phenology and sink: source relations (Fernández et al., 2013). Relatedly, over a brief period, the prevailing temperature during and instantly after the foliar application has different effects based on varieties and mineral elements applied. In pistachio, for example, Zn absorption following the application varied from 9 to 14% as the temperature increased from 8 to 31°C within 24 hours. Within the same temperature range, Zn assimilation in walnut merely increased from 4 to 6%. It is conceivable in the present study, in which the application was done at about 24 °C on sunflower species, there was little or no absorption of mineral elements contained in the applied foliar fertilizers (Vuxal Boron and Spectrum Mo+B), and hence no significant effects.

Materials and Methods. The field research was conducted in the research field of ERPC (educational, research, and production complex) of the Sumy National Agrarian University during 2019-2020 in Ukraine. The experimental plots of Sumy NAU are located within the city of Sumy (latitude 50º52.742N, 34º46.159E Longitude, and 137.7 m above sea level) and belong to the northeastern part of the Forest Steppe. Experiments were carried out on black soil characteristics for the coarse-medium loam.

On the topic of the master's research work, the field research was conducted according to the following scheme.

The scheme of the experiment. Factor A – mustard variety; factor B – seed treatment.

Experiment parameters 1: la = 2, lв= 9; n = 4, the area of the accounting area of 15 m^2. The plots are arranged by the method of organized repetitions in four tiers. The method of sowing is the row method with a row spacing of 15 cm. The seeding rate is 1.5 million pieces of seeds per hectare.

The chlorophyll content in the leaves was determined by preparing a solution in an alcohol extract followed by the determination on a ULAB 102 spectrophotometer. The oil content was determined on the SupNir 2750 infrared analyzer. The statistical analysis of research results was performed using the analysis of variance, correlation, and regression using Exell, Statistica-10 computer programs (DSTU, 2004).

Results. Chlorophyll is the main pigment for photosynthesis in plants. It is a family of lipid-containing pigments located in the membrane. Chlorophyll absorbs most of the red and purple light but reflects green light, so chlorophyll appears green, which plays a central role in the light absorption of photosynthesis. As there is the biosynthetic pathway of chlorophyll in living green plants, chlorophyll can play a role in photosynthesis without photolysis. The seeds were treated with the same growth regulators of Albit, Antistress, Agrinos, Biofoge, Fast Start, Regoplan, Stimulate, and Vermistim D, and the chlorophyll content of the leaves was measured before the plants had matured.

By analyzing Table 1, for Prima, the plants with seeds treated with Biofoge and Vermistim D had the highest fresh weight chlorophyll content – 1.87 mg/g. N-tester: 47.55, 43.50. For Felicia, the plants with Biofoge treated seeds had the highest fresh weight chlorophyll content – 1.26 mg/g. N-tester: 47.60. The chlorophyll content of the plants with seeds treated with the growth regulator of Biofoge increased under the fresh weight of Prima and Felicia leaves.

For the productivity of mustard, the average length of a single pod, the number of seeds per pod, and the seed weight are important factors to measure productivity.

Table 1 - The chlorophyll content of mustard depending on the use of growth regulators with anti-stress action in the forest steppe of Ukraine (2019–2020 yy.)

Factor A	Factor B		
Varieties	Regulators	The content of chlorophylls "a" and "c" in the plant material in fresh weight, mg/g	n-tester
Prima	Control	1.23	42.60
	Albit	1.70	42.15
	Antistress	1.69	48.65
	Agrinos	1.59	46.00
	Biofoge	1.87	47.55
	Fast Start	1.56	45.95
	Regoplan	1.67	44.55
	Stimulate	1.69	45.05
	Vermistim D	1.87	43.50
Average of Prima		1.65	45.11
Felicia	Control	1.16	45.85
	Albit	1.23	47.72
	Antistress	1.20	46.65
	Agrinos	1.15	45.35
	Biofoge	1.26	47.60
	Fast Start	1.13	47.67
	Regoplan	1.24	46.35
	Stimulate	1.14	45.30
	Vermistim D	1.08	50.65
Average of Felicia		1.18	47.02
Duncan test		0.43	6.25

Seeds were treated with the same growth regulators of Albit, Antistress, Agrinos, Biofoge, Fast Start, Regoplan, Stimulate, and Vermistim D, and the average length of individual pods of Prima and Felicia plants, the weight of 25 seeds, the weight of individual pods, and the individual number of pod seeds were measured.

The yield capacity refers to the harvested amount of products needed for cultivation purposes, that is, the harvested amount of grains. The level of output directly affects the economic value. Thousand-grain weight is the weight of one thousand-grain rice in grams, with g as the unit. The index reflects the size and fullness of seeds, it is the content of testing seed quality and crop testing and is an important basis for predicting the yield in the field. For oil crops, the oil content of the seed is an important criterion for measuring the oil yield.

Table 2 - The biological yield capacity and oil content of mustard depending on the use of growth regulators with anti-stress action in the forest steppe of Ukraine (2019–2020 yy.)

Factor A	Factor B			
Varieties	Regulators	Yield, t/ha	Mass 1000 seeds,g	Oil content, %
Prima	Control	1.98	2.60	36.70
	Albit	2.24	2.98	38.46
	Antistress	2.16	2.88	37.42
	Agrinos	2.77	3.69	37.18
	Biofoge	2.92	3.89	39.10
	Fast Start	2.13	2.83	38.91
	Regoplan	3.34	4.45	38.89
	Stimulate	2.25	3.00	37.12
	Vermistim D	2.25	2.99	38.91
Average of Prima		2.45	3.26	38.08
Felicia	Control	2.66	3.55	36.42
	Albit	2.44	3.26	36.92
	Antistress	2.53	3.38	36.57
	Agrinos	2.68	3.57	35.18
	Biofoge	2.56	3.42	38.66
	Fast Start	3.55	4.74	36.69
	Regoplan	2.19	2.91	38.62
	Stimulate	3.84	5.12	36.95
	Vermistim D	2.43	3.24	38.03
Average of Felicia		2.76	3.69	37.12
Duncan test		0.72	1.13	1.38

The plant's yield, thousand-kernel weight, and seed oil content were measured, as shown in Table 2. By analyzing Prima, the plants with Regoplan treated

seeds had the highest biological yield – 3.34 t/ha, and the weight of one thousand seeds was the heaviest – 4.45 g. Plants treated with Biofoge had the highest seed oil content – 39.10%.

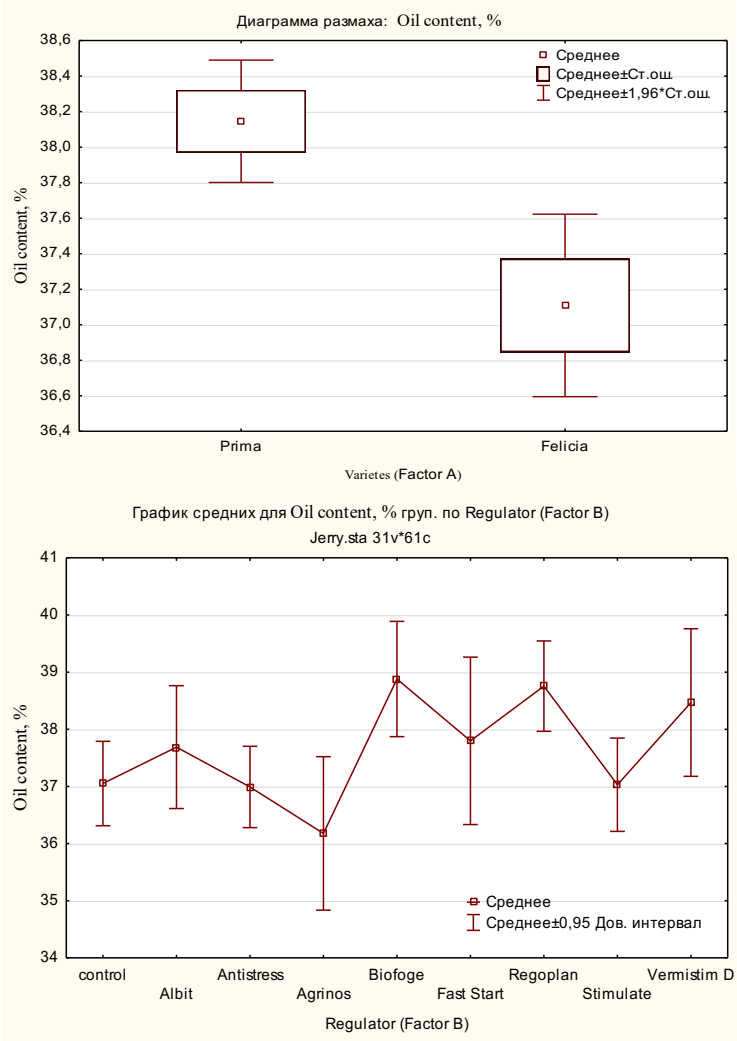

Fig. 1 - Effects of different plant growth regulators on the oil content of mustard seeds (2019–2020 yy.)

For Felicia, the plants with Stimulate treated seeds had the highest yield capacity – 3.84 t/ha, and the weight of one thousand seeds was the heaviest – 5.12

g. Plants treated with Biofoge had the highest seed oil content – 38.66%. The use of Biofoge increased the seed oil content of two varieties of Prima and Felicia.

Conclusions. Based on the results of the research, the following conclusions can be drawn:

1. For Prima, the plants with Regoplan treated seeds had the highest biological yield, 3.34 t/ha, and the weight of one thousand seeds was the heavies – 4.45 g. Plants treated with Biofoge had the highest seed oil content – 39.10 %.

2. For Felicia, the plants with Stimulate treated seeds had the highest yield – 3.84 t/ha, and the weight of one thousand seeds was the heaviest – 5.12 g. Plants treated with Biofoge had the highest seed oil content – 38.66%. The use of Biofoge increased the seed oil content of two varieties of Prima and Felicia.

To obtain the highest yield capacity of brown mustard in the northeastern Forest Steppe of Ukraine. The seeds of Prima variety should be treated with Regoplan growth regulator, the variety of Felicia – with Fast Start or Stimulate growth regulator. To increase the oil content in the seeds, Biofoge growth regulator should be applied.

REFERENCES

1. Danesh-shahraki, A., Kashani, A., Mesgarbashi, M., Nabipour, M. and Koohi-dehkordi, M. (2008). The effect of plant densities and time of nitrogen application on some agronomic characteristic of rapeseed. Pajouhesh&Sazandegi. 79: 10-17.

2. Demirer, T., Ozer, I., Kocturk, O.M., Er., A.Y. (2004). Effects of Different Leaf Fertilizers on Yield and Quality in Sunflower (*Helianthus annuus* L.). Pakistan Journal of Biological Sciences, 7: 384-388. DOI**:** 10.3923/pjbs.2004.384.388

3. Fernández-Martínez, J.M., Pérez-Vich, B., Velasco, L. (2010) Sunflower. In: Oil Crops: Handbook of Plant Breeding 4. New York: Springer; P. 155-232.

4. Kazemeini, S.A., Edalat, M., Shekoofa, A. and Hamidi, R. (2010). Effect of nitrogen and plant density on rapeseed (Brassica napusL.). J. Appl. Sci. 10:1461-1465..

5. Melnik, A. V., Zherdetska, S. V., Ali, S., Romanko, Y. O., Makarchuk, A. V., Akuaku, J. (2015). State and prospects for growing oil crops in Ukraine under the conditions of climate change. Science and World, 1(10), 113−116.

6. Meng Qiufeng, Wang Yuhong, Ren Xiliang, et al. (2006) Preliminary study on horticultural characters of different varieties of mustard vegetables [J]. Modern agricultural science and technology, №21. 25-26.

7. Mobasser, H.R., Shojaee-ghadikolaee, M., Nasiri, M., Daneshian, J., Barari-tari, D. and Pourkalhor, H. (2008). Effect of nitrogen rates and plant density on the agronomic traits of canola (Brassica napusL.) in paddy field. Asian J. Plant Sci. 7: 233-236.

8. Rathke G., Behrens T, Diepenbrock, W. (2006). Integrated nitrogen management strategies to improve seed yield oil content and nitrogen efficiency of winter oilseed rape (*Brassica napus* L.): a review. Agric. Ecosyst. Environ. 117, 80–108.

9. Seeds of agricultural crops. Methods for determining quality: DSTU 4138–2002. [Effective from 01.01.2004]. Kyiv: State Standard of Ukraine, 2003. 173 p. (National standard of Ukraine).

10. Shekhawat, K., Rathore, S.S., Premi, O.P., Kandpal, B.K., Chauhan, J.S. (2012). Advances in Agronomic Management of Indian Mustard (Brassica juncea(L.) Czern. Cosson): An Overview. Hindawi Publishing Corporation International Journal of Agronomy. Volume 2012, Article ID 408284, 14 pages doi:10.1155/2012/408284.

11. Siadat, S.A., Sadeghipour, O. and Hashemi-dezfouli A.H. (2010). Effect of nitrogen and plant density on yield and yield component of Rapeseed. J. Crop Prod. Res. 2:49-62.

12. Sudirman Almi, Noor Jannah. (2019) Effect of Types and Doses of Compost Fertilizer on Growth and Yield of Sawi Plants (*Brassica juncea* L.). Journal AGRIFOR volume 18 issue 1 on page 145 https://doi.org/10.31293/af.v18i1.4121