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Influence of pre-sowing red light radiation and nitragine dressing of chickling vetch seeds on the chemical composition of their yield

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A b s t r a c t. The influence of red light radiation and nitragine treatment of five chickling vetch seed cultivars, on basic nutritional component and mineral element contents in their yield, was evaluated in this paper. Both biostimulation methods interacted in a different way towards chickling vetch seeds, causing the stimulation of different seed yield components. Radiation mainly affected the increase in total protein, crude fibre and mineral element (Na and K) levels. Nitragine treatment influenced the increase of calcium and microelement levels such as Zn and Cu. Single radiation of chickling vetch seeds caused an increase in the total protein level of all varieties of seed yields. Both biostimulation methods caused an increase of Fe in seed yield, but Mg content was, in practice, at the same level in the majority of varieties under study.

K e y w o r d s: *Lathyrus sativus*, radiation, nitragine, total protein, crude fibre

INTRODUCTION

Chickling vetch (*Lathyrus sativus* L.) cultivation is becoming more and more popular in Poland in order to obtain seed for fodder purposes or consumption. This makes it necessary for plant yield to increase. Also necessary is the making of experiments aiming toward the increase of protein content in seeds. Previous studies [1,5-7] indicate that chemical component contents in chickling vetch seeds depends not only on seed variety, but also on the weather and soil conditions as well as agrotechnics (radiation, seed dressing with bacterial inoculum, fertilization and the term of harvest). One of the seed biostimulation methods involves radiation using light of a proper wavelength. It is possible due to the existence of a specific, complex energetic system in plant which absorbs, transforms, stores and utilizes the energy of photons falling onto the plant's organs. Such stimulation [2,4,8] leads to earlier maturation and elevated yielding of plants, and to the occurrance of an increase in stored sugar and protein levels.

Seed dressing using nitragine is another method of crop seed biostimulation. Nitragine is a bacterial inoculum containing a proper bacterium strain and substrate in the form of sterilized soil saturated with a medium. Inoculation efficiency depends on the number of bacteria, inoculum form and type of operation [9].

Chickling vetch, similar to other papilionaceous plants, lives in symbiosis with the *Rhisobium* bacteria, which makes it possible for the plant to utilize the atmospheric nitrogen. Due to such symbiosis, papilionaceous plants are able to live on soils deficient in nitrogenous compounds. From the observations of tubercle formation and yielding of papilionaceous plants it follows that few active bacterium strains exist in soils or they occur in an insufficient number [9]. That is why seeds should be inoculated with nitragine directly before sowing in agricultural practice. This would ensure that the plants had a proper number of active symbiont cells [9]. Symbiotic effectiveness depends on the specificity and virulency of *Rhisobium* bacteria, as well as soil and weather conditions [3,10], agrotechnics and number of possible radiation operations [4].

The aim of the experiment was to evaluate the influence of chickling vetch seed radiation (650-760 nm wavelength light) and nitragine seed dressing on changes in the chemical composition of those seed yields.

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MATERIAL AND METHODS

The experiment was performed using five chickling vetch varieties (Krab, Derek, thick, middle and fine) on plots. It was set on a soil developed from a dust of loess origin and a good wheat complex. Four objects were investigated:

– control (chickling vetch seeds not dressed and non-radiated),
– seeds treated with nitragine,
– single radiated seeds,
– triple radiated seeds.

Chickling vetch seeds were subjected to radiation using light of a 650-760 nm wavelength before sowing. Seeds were radiated once or three times. Cultivation, fertilization and agrotechnics were made according to recommendations for chickling vetch.

Total protein was determined using the Kjeldahl's method: crude fibre using the Henneberg and Stohmann's method. Mineral element levels were recorded using the AAS technique.

RESULTS AND DISCUSSION

Results of total protein, crude fibre and mineral element determination in chickling vetch seed yield after biostimulation with red light are presented in Table 1, those for nitragine treatment – in Table 2.

Pre-sowing radiation of chickling vetch seeds significantly affected the content of all chemical component

T a b l e 1. Effect of pre-sowing flat pea seed irradiation on seed chemical composition

Variety	Object	Crude protein (%)	Raw fibre (%)	Zn (mg kg^{-1})	Na (g kg^{-1})	Cu (mg kg^{-1})	Ca (g kg^{-1})	Fe (mg kg^{-1})	K (g kg^{-1})	Mg (g kg^{-1})
				DM						
	K	25.90	4.81	52.70	0.20	11.97	1.76	67.37	4.24	1.61
Krab	1x	27.34	4.66	43.09	0.25	15.55	1.68	55.67	4.46	1.66
	3x	25.41	4.93	53.53	0.23	9.45	1.73	89.45	5.05	1.39
$\bar{x}$		26.22	4.80	49.78	0.23	12.32	1.72	70.83	4.59	1.56
	K	28.09	4.88	51.11	0.36	16.74	1.50	58.64	4.88	1.67
Derek	1x	29.20	5.45	50.34	0.63	9.06	1.57	81.67	5.07	1.65
	3x	28.56	5.03	56.52	0.23	19.65	1.88	72.08	4.59	1.54
$\bar{x}$		28.62	5.12	52.66	0.41	15.15	1.65	70.80	4.85	1.62
	K	25.26	5.05	51.17	0.38	17.09	1.72	57.53	4.76	1.18
Coarse seed	1x	25.57	4.90	36.83	0.20	11.48	1.77	72.75	4.57	1.90
	3x	26.03	4.86	49.49	0.25	14.82	1.64	59.27	4.46	2.06
$\bar{x}$		25.62	4.94	45.83	0.28	14.46	1.71	63.18	4.60	1.71
	K	26.87	5.23	45.24	0.28	15.37	1.81	58.00	4.13	1.35
Medium seed	1x	26.89	5.08	45.38	0.34	11.89	1.79	71.86	4.91	1.08
	3x	26.87	5.75	46.41	0.23	10.66	1.61	65.70	4.34	2.76
$\bar{x}$		26.87	5.35	45.68	0.28	12.64	1.74	65.19	4.46	1.73
	K	29.59	4.82	57.81	0.19	17.00	2.23	75.69	4.35	2.37
Fine seed	1x	30.13	5.91	55.35	0.54	8.93	1.82	87.83	5.98	1.51
	3x	28.54	5.34	55.44	0.20	11.39	1.65	65.03	4.53	1.96
$\bar{x}$		29.42	5.36	56.20	0.31	12.44	1.90	76.19	4.95	1.95
$\bar{x}$ (independent of variety)	K	27.14	4.96	51.61	0.28	15.63	1.80	63.45	4.47	1.64
	1x	27.82	5.20	46.26	0.38	11.53	1.72	72.62	4.91	1.69
	3x	27.08	5.18	52.28	0.23	13.19	1.70	70.31	4.59	1.94
$\bar{x}$ (independent of combination)		27.35	5.11	50.03	0.30	13.40	1.74	0.10	4.69	1.71

K – control seeds, 1x – seeds irradiated ones, 3x – seeds irradiated three times, DM – dry matter.

T a b l e 2. Effect of Nitragine flat pea seed dressing on seed chemical composition

Variety	Object	Total protein (%)	Raw fibre (%)	Zn ($mg\ kg^{-1}$)	Na ($g\ kg^{-1}$)	Cu ($mg\ kg^{-1}$)	Ca ($g\ kg^{-1}$)	Fe ($mg\ kg^{-1}$)	K ($g\ kg^{-1}$)	Mg ($g\ kg^{-1}$)
				DM						
Krab	K	25.90	4.81	52.70	0.20	11.97	1.76	67.37	4.24	1.61
	N	26.04	5.45	75.45	0.28	24.26	1.98	88.02	4.17	1.55
$\bar{x}$		25.97	5.13	64.07	0.24	18.11	1.87	77.70	4.21	1.58
Derek	K	28.09	4.88	51.11	0.36	16.74	1.50	58.64	4.88	1.67
	N	26.51	5.16	69.02	0.31	15.00	2.12	95.43	4.11	1.58
$\bar{x}$		27.30	5.02	60.07	0.33	15.87	1.81	77.04	4.50	1.63
Coarse seed	K	25.26	5.05	51.17	0.38	17.09	1.72	57.53	4.76	1.18
	N	24.45	4.60	55.97	0.44	12.31	1.59	61.17	4.88	1.36
$\bar{x}$		24.86	4.82	53.57	0.41	14.70	1.66	59.35	4.82	1.27
Medium seed	K	26.87	5.23	45.24	0.28	15.37	1.81	58.00	4.13	1.35
	N	25.16	4.74	55.15	0.16	20.12	1.51	44.46	3.76	1.63
$\bar{x}$		26.01	4.99	50.20	0.22	17.74	1.66	51.23	3.95	1.49
Fine seed	K	29.59	4.82	57.81	0.19	17.00	2.23	75.69	4.35	2.37
	N	27.53	5.18	68.02	0.12	16.81	3.74	86.31	4.08	1.89
$\bar{x}$		28.56	5.00	62.91	0.16	16.90	2.98	81.00	4.21	2.13
$\bar{x}$ independent of variety	K	27.14	4.96	51.61	0.28	15.63	1.80	63.45	4.47	1.64
	N	25.94	5.02	64.72	0.26	17.70	2.19	75.08	4.20	1.60
$\bar{x}$ independent of combination		26.54	4.99	58.16	0.27	16.67	2.00	69.26	4.34	1.62

N – Nitrogen treated seeds. Other explanations as in Table 1.

contents in seeds. The best effects were achieved using single radiation. Increase of total protein level due to single radiation occurred for all varieties studied. In the thick-seed variety, a significant increase of that item took place after triple radiation.

Crude fibre content decreased in only one case (thick-seed variety) due to radiation; the increase of that item level occurred in other varieties after single or triple radiation.

From our earlier experiments using radiated seeds it follows that if there is any light energy capacity it may be absorbed by those seed cells. Initially, an increase in the number of radiations at constant laser or white light flux, or at a given wavelength causes the increase of plant yielding. However, at some absorbed energy level, further radiation does not affect the yielding. It also depends on the kind of seed being radiated and the sowing time after radiation.

Nitragine dressing mainly affected the mineral element contents – especially in Krab cv. The increase of all chemical component levels in relation to control occurred for that variety. Protein content increased only to a minimum extent for Krab cv. Other varieties reacted with a decrease in protein level after nitragine treatment, which proves the biological incompatibility between particular chickling vetch varieties and bacteria.

In Krab, Derek and fine-seed varieties, only a slight increase of crude fibre content took place. That component level is disadvantageous to animals, but on the other hand, it is recommended in the human diet.

Bacterial inoculum applied had an influence on the increase of Zn content in all variety seeds. Other mineral component levels, in seeds treated with nitragine, were variable in relation to the control for particular chickling vetch varieties. In the case of Derek cv., an increase in Ca and Fe contents also occurred: in thick-seed – Na, Fe, K and Mg; in middle-seed – Cu and Mg; and in fine-seed – Cu, Ca and Fe levels increased.

Among all varieties studied, the lowest increase of mineral element levels was observed in the thick-seed, and the highest in the Krab, Derek and middle-seed varieties.

On the basis of data presented in Tables 1 and 2, one should conclude that particular types of chickling vetch seed biostimulation had different influences on components of seed yield. Radiation mainly affected the total protein, crude fibre and macroelement (Na and K) contents, whilst nitragine treatment affected the increase of calcium and microelement levels such as Zn and Cu. It is worth mentioning that the increase of Fe content in seeds resulted from both methods of stimulation in the majority of varieties studied. Besides Krab cv., nitragine treatment does not cause the increase of Mg level in any other variety.

CONCLUSIONS

1. Chickling vetch seed biostimulation using light of a 650-760 nm wavelength and nitragine treatment caused changes in the chemical composition of its seed yield.

2. Both biostimulation forms, interacting in a different way towards chickling vetch seeds, caused stimulation of various components of seed yield. Radiation mainly affected the increase in total protein, crude fibre and mineral element (Na and K) levels. Nitragine treatment influenced the increase of calcium and microelement levels such as Zn and Cu.

3. Single radiation of chickling vetch seeds using light of a 650-760 nm wavelength caused the increase of total protein level in all varieties of seed yields.

4. The iron content increase in seed yield was due to both biostimulation methods in the majority of varieties studied.

5. Besides Krab cv., nitragine treatment and light radiation did not cause a significant increase of Mg level in seed yield.

REFERENCES

1. **Carnomyrdina T.A. and Kogut P.M., 1984.** Influence of presowing laser biostimulation on some photosynthesis parameters of spring wheat. Problems of plant Photoenergetic and Crop Incrising. All – Union Conf. Lwów, 254, 126-131.
2. **Drozd D., 1994.** Influence of pre-sowing grain laser radiation on elements of yield structure in spring wheat. Zesz. Nauk. AR, Wrocław, 254, 63-69.
3. **Dziamba Sz., Bojarska U., and Cebula M., 1997.** Influence of chickling vetch inoculation with *Rhisobium* strains on yield and its structure. Proc. Conf., Radom, June 9-10, 45-48.
4. **Dziamba Sz. and Koper R., 1992.** Influence of seed laser radiation on spring wheat yield. Fragmenta Agronomica, 1, 33, 88-93.
5. **Inyushin W.M., Iliasor G.U., and Fedorowa N.N., 1981.** Laser Light and Crop. Kainar Publ., Ałma-Ata.
6. **Karlander E.P. and Kraoso R.W., 1968.** The laser a light source for the photosynthesis and growth of *Chlorella vaunielli*. Biochim. Biophys. Acta, 153, 1, 312-314.
7. **Podleśny J., 1997.** Influence of seed dressing with nitragine and molybdenum and nitrogen fertilization on white lupine yielding. Zesz. Probl. Post. Nauk Roln., 446, 287-290.
8. **Popp F.A., 1992.** Biology of Light. PWN, Warszawa.
9. **Rajs R., 1989.** Influence of seed inoculation with nitragine on development and yield of pea. Natural and agrotechnical conditions of leguminous plant seed production. Proc. Conf., Puławy, November 8-9, 74-75.
10. **Strzelec A., 1989.** Review of studies upon symbiotic binding of a free nitrogen. Microorganisms in soil and its fertility. Proc. Conf., Puławy, October 14, 43-50.