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Influence of pre-sowing red light radiation on the content of antinutritional factors, mineral elements and basic nutritional component contents in triticale seeds

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A b s t r a c t. Changes of dry matter, crude ash and total protein contents in triticale Gabo and Migo cv. whose seeds were previously single radiated using red light, were found. The protein level in treated seeds increased by 10.2–16.2% in relation to non-treated ones. Crude ash and dry matter levels in both cultivar radiated seeds decreased by 0.3–1.1% of dry matter and 7–9% of crude ash as compared to non-radiated seeds. Red light radiation of seeds did not affect the phytate and alkyloresorcinole contents in seeds. Triticale seed radiation with red light caused the increase of mineral element contents, notably that of sodium, zinc and iron, but to a lesser extent of potassium and calcium; magnesium level decreased.

K e y w o r d s: pre-sowing, red light radiation, antinutritional factors, mineral elements, triticale seeds

INTRODUCTION

Pre-sowing laser biostimulation of crop seeds is of growing practical interest due to significant positive effects referring to crop yielding. Results of lengthy studies performed at the University of Agriculture, Lublin by Dziamba and Koper [4] and Koper and Dziamba [7] confirm positive effects of laser seed biostimulation cited in local and foreign literature [2,3,5,6,10].

Studies carried out at the University of Agriculture, Lublin allowed development of the technology of pre-sowing laser biostimulation of both crop and vegetable seeds. Within those studies, prototypical stands for seed biostimulation using He-Ne laser were constructed [7].

As it is well-known, besides energy stored in proteins, ATP, sugars and other metabolites of intermediate metabolism, every plant has a great energy source accumulated in its whole structure in the form of bioplasma. Elevating the bioplasma energetical potential gives the effect of seed stimulation. Bioplasma and subtle fields of physical character formed by it make interaction between seeds or plants possible. Such interaction allows exchange of energy between seeds and it determines the plant cell ability to absorb photons of a proper wavelength.

Therefore, it is possible to utilize right energy doses of red (helium-neon lasers) or white light radiation for pre-sowing biostimulation of crop seeds which is aimed at elevating the seed energetical potential, to improve its germination ability and to strengthen young plants at the first stage of their development. Plants positively react towards light radiation of 630–650 nm wavelength.

Results of studies upon the pre-sowing laser seed biostimulation performed at the University of Agriculture, Lublin by physicists and detailed plant cultivation experts univocally point to the yielding increase of plants grown from seeds subjected to He-Ne laser or white light biostimulation.

Better shooting, greater resistance to frosts and shortening of the plant maturation are additional effects of laser seed biostimulation.

Study results of Dobrowolski *et al*. [3] proved that pre-sowing laser seed biostimulation caused positive changes in a wide range of some element absorption by plants grown from such seeds.

It is also known the fact of periodical accumulation of energy absorbed by plant cells. Seeds radiated with laser or IR light and not sown during 2–3 weeks after that operation lost their biostimulation properties.

The aim of study was to compare the basic nutritional components, antinutritional factors (ANF) as well as chosen

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mineral macro- and microelements in triticale seeds radiated and non-radiated with red light.

MATERIAL AND METHODS

Triticale seeds of Gabo and Migo cv. originating from Polish varieties were used in studies. After seed grinding, determination of basic nutritional components according to Polish Norms was performed. Mineral element contents were recorded using the AAS technique, phytates – by means of Oberlass method [9], alkyloresorcinoles – by means of Matyka *et al.* method [8] and pentosans – using Bassler method [1].

RESULTS

Contents of chosen basic nutritional components, antinutritional factors and mineral elements in triticale seeds of cultivars studied and radiated with red light are presented in Tables 1–3.

Crude ash, dry matter and total protein were basic nutritional components under analysis. Ash and dry matter content in radiated seeds of both cultivars decreased in relation to non-radiated from 0.3 to 1.1% of dry matter and from 7 to 9% of crude ash. The protein level in radiated seeds increased in relation to non-radiated ones from 10.2 to 16.2%. Higher values of crude ash and dry matter were obtained for Gabo cv.; Migo cv. achieved better results referring to total protein. That item increase was similar for both cultivars. Antinutritional factors (ANF) including phytates, pentosans and alkyloresorcinoles play an important role in triticale seeds. Their levels for both cultivars, radiated and non-radiated, are presented in Table 2.

Red light radiation of seeds did not affect the phytate and alkyloresorcinole contents. However, biostimulation of triticale seeds using red light caused an increase of pentosan quantity. Amounts of macroelements (sodium, potassium, calcium and magnesium) and microelements (iron and zinc) in radiated and non-radiated triticale seeds are presented in Table 3.

Triticale seed radiation affected the increase of mineral element levels, notably that of sodium, zinc and iron, but to a lesser extent potassium and calcium; magnesium content did not decrease.

T a b l e 1. Contents of basic nutritional components in triticale seeds of Gabo and Migo cv. radiated and non-radiated with red light

Basic nutritional components	n	Units	Variety	Seeds non-radiated			Seeds radiated		
				M	S	V	M	S	V
Dry matter	30	g kg^{-1}	Migo	905.2	3.10	0.4	902.5	3.20	0.5
	30		Gabo	913.5	3.32	0.4	903.4	4.15	0.4
Crude ash	30	mg kg^{-1} m^{-2}	Migo	20.0	1.88	8.4	18.2	1.17	6.1
	30		Gabo	25.5	2.12	9.5	23.5	1.80	6.5
Total protein	30	mg kg^{-1} m^{-2}	Migo	151.94	10.07	8.9	169.21	12.22	8.8
	30		Gabo	94.53	11.74	9.1	112.79	11.74	9.0

M – mean value, S – standard deviation, V - variability.

T a b l e 2. Contents of antinutritional factors (g kg^{-1} m^{-2}) in triticale seeds of Gabo and Migo cv. radiated and non-radiated with red light

ANFs	n	Variety	Seeds non-radiated			Seeds radiated		
			M	S	V	M	S	V
Phytate	30	Migo	9.58	1.10	13.0	9.72	1.10	12.7
	30	Gabo	10.76	1.12	12.0	10.45	4.31	11.2
Pentosan	30	Migo	82.35	6.22	9.1	97.81	7.32	11.3
	30	Gabo	102.33	7.02	9.7	104.80	8.02	12.1
Alkyloresorcinole	30	Migo	0.95	0.12	15.0	1.10	0.18	17.0
	30	Gabo	1.11	0.13	15.0	1.13	1.17	16.0

Explanations as in Table 1.

T a b l e 3. Contents of mineral elements (mg kg^{-1} m^{-2}) in triticale seeds of Gabo and Migo cv. radiated and non-radiated with red light

Mineral elements	n	Variety	Seeds non-radiated			Seeds radiated		
			M	S	V	M	S	V
Sodium	30	Migo	181.88	13.19	9.8	255.29	14.12	10.1
	30	Gabo	192.25	14.22	10.2	265.10	14.32	10.5
Potassium	30	Migo	1846.34	11.24	12.4	2054.67	12.13	13.2
	30	Gabo	1929.10	12.03	11.9	2221.01	13.42	11.7
Calcium	30	Migo	53.68	3.21	31.5	65.03	14.27	35.7
	30	Gabo	66.17	114.12	32.1	69.19	14.40	35.0
Magnesium	30	Migo	1313.43	14.27	13.8	1285.43	15.25	14.2
	30	Gabo	1412.25	14.80	12.9	1328.12	14.62	13.5
Iron	30	Migo	71.31	9.02	18.7	97.22	10.02	19.8
	30	Gabo	73.25	9.00	17.9	100.00	13.10	20.8
Zinc	30	Migo	55.00	9.00	19.2	75.18	11.05	20.9
	30	Gabo	56.00	9.50	18.1	79.10	11.12	22.1

Explanations as in Table 1.

DISCUSSION

Utilizing the red light for pre-sowing crop seed biostimulation is aimed, among other things, at elevating the energetical potential of seeds, improving their germination ability, strengthening young plants at the first stage of their development, as well as finding out and comparing the basic nutritional component, mineral element and antinutritional factor contents in seeds subjected to radiation with non-radiated ones.

Earlier study results univocally pointed not only to the increase of yielding of plants grown from white or laser light operation, but also to the changes in their chemical composition.

Higher values of radiated triticale seed yields obtained were similar to those referring to germination data found by Dziamba and Koper [4].

Content of nutritional components

Levels of basic nutritional components (crude ash, total protein and dry matter) in radiated and non-radiated triticale seeds presented in Table 1 were variable. Mean values of dry matter in non-radiated seeds were higher than in those after radiation. Mean values of crude ash in non-radiated seeds were also higher in relation to mean seed yield after light treatment. However, results for total protein content revealed the increase of that item value in radiated seeds by 10.2–16.2%.

Content of antinutritional factors

Analyzing phytic acid content (Table 3) in once radiated and non-radiated triticale seeds results in the conclusion that the radiation factor had no influence on that component level. No further radiation (triple) caused the changes referring to phytic acid content in triticale seeds. It is worth mentioning that chickling vetch seed extrusion under different temperature conditions did not affect the phytic acid level changes either. From those studies it follows that phytic acid is an ANF resistant to radiation. Similarly, seed light treatment did not have an influence on alkyloresorcinole content. Only a greater difference for Migo cv. was observed. However, the pentosan level increased in both cultivar seeds subjected to single red light biostimulation.

Content of mineral elements

As opposed to phytic acid, mineral elements showed high differentiation of their contents in radiated and non-radiated triticale seeds. As compared to the control (non-radiated seeds), all the results (except from magnesium) were higher after red light biostimulation. Macroelement (sodium, calcium, potassium) and microelement (iron, zinc) content increase was observed. However, a decrease in magnesium level was found.

Changes of basic nutritional components, ANFs and mineral elements were probably associated with intensified vegetation of triticale grown from radiated seeds. Moreover, both weather condition variability in a given year and mineral element contents in a soil should also be taken into account at interpretation of results.

CONCLUSIONS

1. Changes of dry matter, crude ash and total protein contents were found in triticale seeds of Gabo and Migo cultivars single radiated with red light.

2. Protein level in treated seeds increased by 10.2–16.2% in relation to non-treated ones.

3. Crude ash and dry matter levels in both cultivar radiated seeds decreased by 0.3–1.1% of dry matter and 7–9% of crude ash as compared to non-radiated seeds.

4. Red light radiation of seeds did not affect the phytate and alkyloresorcinole contents in seeds.

5. Seed biostimulation using red light had an influence on pentosan level increase in both cultivar seeds.

6. Triticale seed radiation with red light caused the increase of mineral element contents, notably that of sodium, zinc and iron, but to a lesser extent of potassium and calcium; magnesium level decreased.

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