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NOVOSTI O HELJDI – LES ANNALES DE SARRASIN

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FAGOPYRUM (Buckwheat Newsletter) is open to everyone interested in buckwheat and will cover all aspects of buckwheat research: genetics, cytology, breeding, cultivation, nutrition, utilization, biochemistry and other. Scientific papers, reviews, research notes on work in progress or on results not yet published: comments and speculations related to buckwheat; list of stock materials wanted or available; lists of names, addresses and field of work of scientists who have expressed the desire to receive the Newsletter; lists of publications which are related to buckwheat and which have appeared during preceding years; announcements concerning the promotion of research on buckwheat (workshop, symposia, and so on): abastracts and/or contents of published papers/books on buckwheat; bibliographies and other information related to buckwheat or buckwheat research will be published.
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Characteristics of buckwheat grain mineral components and dietary fiber

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In search for co called healthy food sources of high nutritive value chemists and technologists turned to buckwheat. The result of investigations is chemical and physical-chemical characteristics buckwheat protein (14, 15, 18) and determined high nutritive value (11); its available carbohydrates (19) and lipids (20) are better and better described. Relatively little research has been devoted to mineral components and nonavailable carbohydrates. Acc. to Ruszkowski and Ruszkowska (16), apart from phosphorus and iron, buckwheat grain contains potassium, zink, and some small amounts of boron, iodine, nickel and cobalt. Acc. to Trzebska-Jeske (21) buckwheat groats contain potassium, boron, iron, copper, chromium, zink, cobalt, nickel, and also calcium, magnesium, phosphorus and sodium. Similar chemical composition of mineral salts was stated by Zalesskaja and Mielnikow (23) though it varied in quality from other data (21). Buckwheat grain INQ for mineral components was acc. to Amarowicz and Fornal (1) P – 3.10, Fe – 1.91, Mg – 4.62, Zn – 1.98. These figures, greater than 1.00, prove that buckwheat groats can satisfy demands of mineral components in a higher degree than his energetical demands. There is no unanimous view on the qualitative and quantitative mineral composition accompanying structural carbohydrates. Their definition of the last decade takes into account fractions of hemicelluloses, celluloses and lignins and of other substances, which do not undergo enzymatic hydrolysis. The content of structural carbohydrates in buckwheat was acc. to the 1960s definition, or so colled crude fiber, 12–18 % d.m. Crude fiber content in the seed coat was determined as ab. 50 %, and in groats – as ab. 1 % (12).

Above nonunanimous statements made us undertake research aiming at determining the content of selected mineral components in buckwheat grain, flour, groats and seed coat, as well as at determing dietary fiber content and its fractions in the same material.

Materials and methods

Seed coat, groats and flour obtained from trade buckwheat grain were investigated. Material was reduced in size to > 315 μm granulated product.

Mg, Fe, Zn, Cu and Mn content was determined with AAS, K with flame photometry (17). Nitric acid and perchloric acid mixture (4 : 1, v v) was applied for mineralization. The IL 353 spectrophotometer and Flapho IV flame photometer were used. After 1.5 h preheating at water boiling temperature dietary fiber was determined acc. to Hellendoorns method (17), and acid detergent fiber – acc. to Van Soests method (22).

Dietary fiber = hemicelluloses + celluloses + lignins

Acid detergent fiber = celluloses + lignins

Discussion of results

Mineral components content in the examined material was characterized by a diverse distribution (Tab. 1). Compared to cereal grain buckwheat seed coat is rich only in iron and manganese, while compared to whole buckwheat grain it contains less zinc, copper and potassium, and less manganese. Hence it can be assumed that buckwheat endosperm is very rich in mineral salts and removing seed coat does not affect qualitative-quantitative composition of flours mineral salts.

Compared to flour buckwheat groats were found to contain less zinc, manganese and iron, and more potassium and magnesium. This points to the possibility of migrating of these elements from seed coat to the possibility of migrating of these elements from seed coat to endosperm during hydrothermic treatment. Magnesium and potassium content in the investigated material is higher than in cereal grain and its products.

From the nutritional point of view content of Mg, an element esential for the right course of many biochemical processes in human organism, is especially valuable.

Results obtained for buckwheat grain are for Mg, K and Cu lower, and for Zn and Mn higher than those quoted by Javornik (12). Considerably higher amounts of Mg (362–365 mg %) was found in buckwheat by Kusano et al (13). Bubicz and Sklarz (4) and Bubicz et al. (3) observed much lower level of Mg (62–82 mg % for the Emka veriety and 93–109 mg % for the Hruszowska variety). They also noticed similar contents of Zn, Cu, Mn and Fe, and higher K level than in the present work. Investigating buckwheat groats Trzebska – Jeske et al. (21) presented following values (mg 100 g d.m.): Mg – 216, Fe – 2.82, K – 475, Cu – 0.40, Zn – 3.50, Mn – 2.04. In Dietrych-Szóstaks and Ploszynskis work (6) Mg content in groats was 200–300 mg/100 g d.m. and on the way of dehulling.

The problem of dietary fiber has been the object of interest of many chemists and nutritionists for the last decade. Developing new methods of determining contributed to investigating quality and quantity composition of dietary fiber in cereal grain and in other seeds. The results of our investigations characterize fractional composition of dietary fiber of buckwheat grain and its products (Tab. 2).

Dietary fiber content in groats and flour was much lower than in buckwheat grain while seed coat was found to contain 3 times more fiber than the grain. In fractional composition of dietary fiber in the examined material there is a noticeably higher amount of lignins and celluloses in comparison to hemicelluloses (Fig. 1). The seed coat fiber contained the greatest amount of celluloses and lignins, and this relation brings upon seed coat nonconsumption utilization (10). An interesting phenomenom is the presence of hemicelluloses in buckwheat groats. It can be assumed to be result of celluloses changing during hydrothermic process. It is quite possible that forms of higher solubility remained in acid solution of detergent and eventually the results of hemicelluloses content were overestimated.

Dietary fiber content determined in our investigations is higher then it is in so called crude fiber (2). For various buckwheat varieties crude fiber contents are following: 15.17–15.79 % (3), 13.71–15.21 % (4), 17.79 and 12.72 % d.m. (9). In buckwheat groats they were 1.18 % d.m. (10), 0.29 % d.m. (9), and 0.24–0.60 % d.m. (7), and in seed coat – 44.49 % d.m. (8). Bulinski et al. (5) found in buckwheat groats higher contents of dietary fiber, i.e. 8,38–10.21 % d.m. Also Dietrych-Szóstak and Ploszynski (6) showed higher part of celluloses and hemicelluloses than the present results. The divergences may be result not only from applying different analytical methods but also from the range of buckwheat varieties.

Summing up the present results it is worth stressing the typical quality and quantity composition of mineral components in buckwheat grain and its products whereas the composition of dietary fiber being dominated by celluloses and lignins. In cereal grain the main fraction of the fiber are hemicelluloses making 60 % of cereal bran.

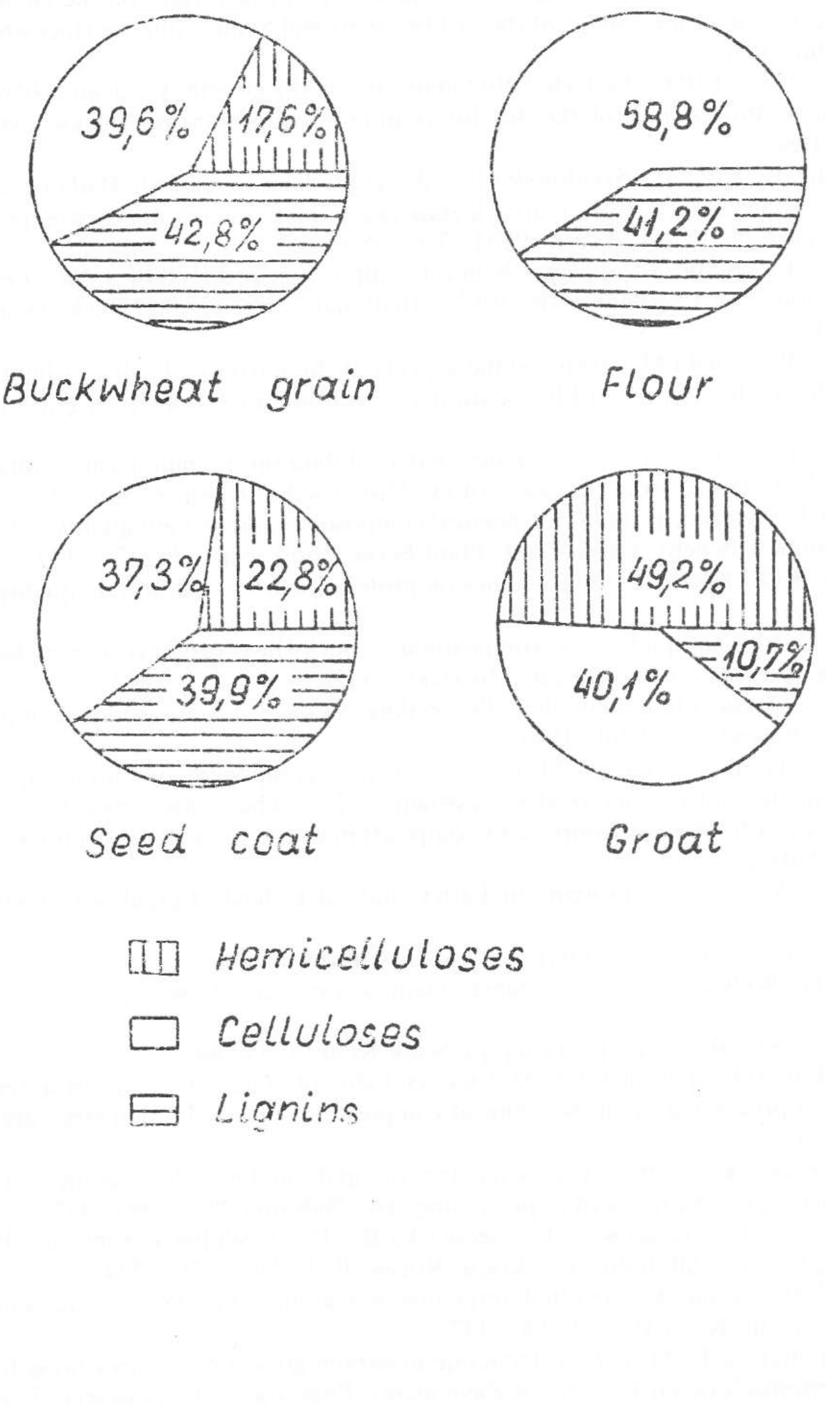
Table 1. Mineral components content in buckwheat and its products (mg/100 g)

Material	K	Mg	Mn	Fe	Zn	Cu
Buckwheat grain	244,1	168,6	5,44	4,82	3,40	0,59
Flour	299,4	160,8	2,22	5,26	3,72	0,53
Seed coat	248,0	120,6	13,09	5,61	2,49	0,49
Groat	301,5	172,9	1,53	3,69	2,96	0,79

Table 2. Dietary fiber content and its composition in buckwheat grain and its products (% d.m.)

Material	Dietary fiber	Acid detergent fiber	Hemi-celluloses	Celluloses	Lignins
Buckwheat grain	24,75	20,39	4,36	9,81	10,58
Flour	3,94	3,98	0,00	2,34	1,64
Seed coat	80,31	61,98	18,33	29,93	32,05
Groat	4,51	2,29	2,22	1,81	0,48

Fig. 1. Composition of dietary fiber in buckwheat grain and its products



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Izvleček

V zrnju, moki in ajdovi kaši so bile analizirane mineralne snovi in vlakna. S prehranskega vidika je pomembno, da je v zrnju ajde več magnezija kot v zrnju drugih žit. V ajdi je tudi razmeroma veliko vlaken, zlasti celuloze in lignina, medtem ko med vlakni žit prevladujejo hemiceluloze.

Occurrence of phenolic compounds in four cultivated buckwheats with particular reference to grain quality.

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Key words: buckwheat, phenolic compounds, species.

Buckwheat *(Fagopyrum* sp., Fam. Polygonaceae) are economically important primarily due to their nutritious grains (Tahir and Farooq [10]), besides foliage being used as a green vegetable (Narain [6]). Four speices of *Fagopyrum* viz. *F. esculentum* Moench, *F. sagittatum* Gilib., *F. tataricum* Gaertn. and a new species *F. kashmirianum* Munshi [5] grow in mixed stands at various high altitude areas of Kashmir as reported by Tahir and Farooq [9]. The present communication reports the occurrence of some phenolic compounds in foliage and in grains of the four species with a view for subsequent improvement of grain quality.

The phenolic compounds were separated on paper chromatograms from ethanolic extracts according to Margna and Margna [4], using upper phase of isoamyl alcohol-petrol ether, acetic acid and water (3:1:1:1) as the solvent system. The spots were located by viewing the chromatograms directly under UV light using a Toshniwal UV lamp with emission maximum at 360 nm. Besides the chromatograms were also viewed under UV light after exposing them to NH_3 vapour or spraying them with $AlCl_3$.

In the leaf tissue fractions two compounds separated each at R_f 0.33 and 0.94 were located on chromatograms in each of the four buckwheat species; the former spot corresponded to rutin due to its typical UV light absorption characteristics, the latter could not be characterised. The present finding is commensurate with the widely known occurrence of rutin in the leaves of *F. esculentum* and *F. tataricum* (Singh and Atal [8]).

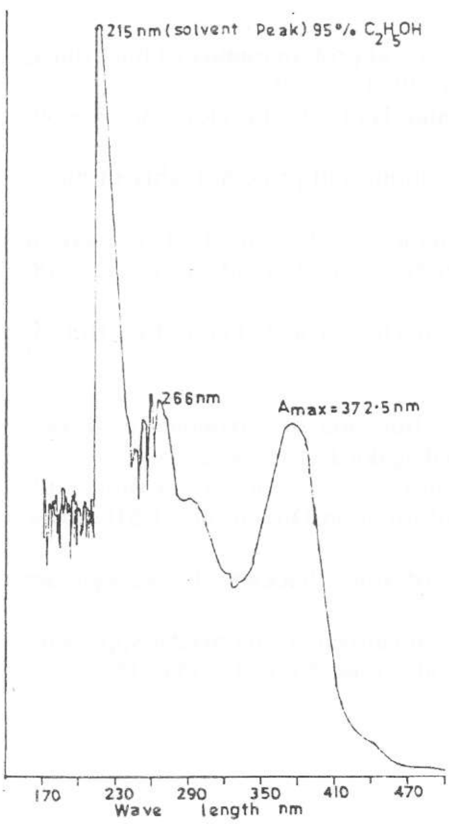

Fig. 1. UV-visible light absorption spectrum of the flavonoid compound in the groat fraction of grains of *Fagopyrum kashmirianum* located at R_f 0.58 on paper chromatograms.

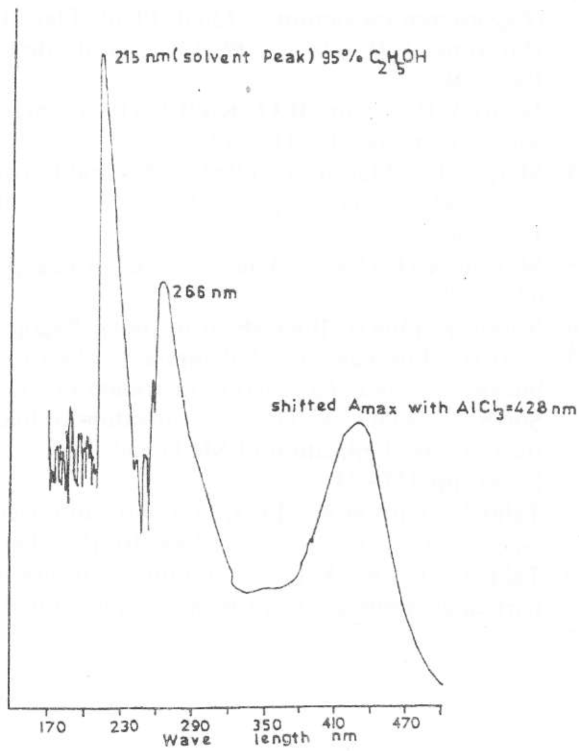

Fig. 2: Bathochromic shift observed in A_{max} of the flavonoid compound detected in the groat fraction of the grains of *Fagopyrum kashmirianum* at R_f 0.58 on paper chromatograms.

The chromatograms of hull fraction of grains, when viewed under UV light showed a prominent spot of rutin at R_f 0.36 in each of the four species, however, the spot was inconspicuous in case of *F. kashmirianum*. The chromatograms of the groat fraction, when viewed under UV light and exposed to NH_3 vapours showed the presence of two spots possessing yellowish absorbance; separated each at R_f 0.58 and 0.83 in each *F. sagittatum*, *F. tataricum* and *F. kashmirianum*, however, both the spots were absent in *F. esculentum*. When the chromatograms of the groat fraction were sprayed with $AlCl_3$ and observed under UV light, the spot at R_f 0.58 gave intense yellow fluorescence and that at R_f 0.83 gave faint yellow fluorescence.

The compound separated at R_f 0.58 in the groat fraction has tentatively been characterised. The clear eluate of the flavonoid spot in 95 % ethanol was subjected to spectrophotometry in the UV visible range (170–500 nm) in a Pye Unicam model Sp8-100-UV spectrophotometer. Study of the absorption spectra of the compound showed that the compound has its A_{max} at 372.5 nm (Fig. 1). Addition of a drop of 5 % alcoholic $AlCl_3$ produced a 56 nm bathochromic shift in A_{max} (Fig. 2). These characteristics closely correspond to those of the flavonol quercetin which has its A_{max} at 374 nm and produces a 70 nm bathchromic shift with $AlCl_3$ (Harborne [2]). The present findings are commensurate with those of Sato et al. [7], who have isolated and identified quercetin from the grains of tartary buckwheat.

The better palatability of the grains of *F. esculentum* has been attributed to a low content of phenolics both in hull and groat fractions as compared to the other three species [10]. Besides, the low protein digestibility of buckwheat grains has been attributed to a high content of phenolics by Eggum et al. [1] and Javornik et al. [3]. Inspite of this disadvantage the buckwheat species high in phenolic content predominate in this region where these are cultivated in mixed stands [9]. Surprisingly the phenol rich grains belong to the species which are self compatible (unpublished results of the authors). The grain quality of the three self compatible buckwheats could be improved by testing various genetical procedures.

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Izvleček

Pri štirih vrstah rodu *Fagopyrum* so bile analizirane fenolne snovi. V listju štirih vrst sta bili ugotovljeni s pomočjo kromatografije dve fenolni spojini, od katerih je ena rutin, druga pa je še neidentificirana. Raziskava listov je pomembna, saj se ajdovo listje uporablja kot zelenjavo. V luskah zrn je izrazito prisoten rutin. Kromatogrami kaše kažejo razen pri F. esculentum dve rumenkasti mesti.

Fagopyrum 7 (1987): 9–12

Comparative study of some growth attributes in buckwheats (*Fagopyrum* sp.) cultivated in Kashmir

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A comparison has been made of some growth attributes of four species of *Fagopyrum* viz. *F. esculentum* Moench, *F. sagittatum* Gilib., *F. tataricum* Gaertn, and *F. kashmirianum* Munshi. *F. esculentum* attains maximum dry weight, leaf area and height earlier as compared to the other three species, among which *F. tataricum* attains maximum values for these parameters at a later stage. *F. tataricum* seems to possess a higher productivity potential owing to its longer growth span. *F. esculentum* shows higher values for net assimilation rate (NAR) and relative growth rate (RGR). The biomass duration (BMD) and leaf area duration (LAD) was found to be maximum in *F. tataricum*, however, *F. esculentum* attained peak values for BMD and LAD at an earlier stage as compared to the other three species.

Introduction

Buckwheats (*Fagopyrum* sp., Fam. Polygonaceae) are economically important due mainly to their protein rich grains, hardiness of plants, short growth span, besides foliage being used as a green vegetable (Tahir and Farooq, 1983, 1985; Narain, 1983). Four species of *Fagopyrum* viz. *F. esculentum* Moench, *F. sagittatum* Gilib., *F. tataricum* Gaertn. and *F. kashmirianum* Munshi have been reported to grow in mixed stands at certain high altitude areas of Kashmir (Tahir and Farooq, 1983).

Only a little information is asvailable on various phytometric characteristics of buckwheats (Midorikawa, 1957; Ivaki, 1959; Tahir and Farooq, 1983; Kajfež-Bogataj and Knavs, 1985; Kajfež-Bogataj and Gaberščik, 1986). The role of phytometric investigations in studies of plant stand architecturę is very important for studying productivity and especially for modelling of canopy net photosynthesis (Ross, 1981). Growth analysis helps to elucidate the interaction between the crop and its physical environment. The study shall enable the modelling of buckwheat production for various genotypes with different growth patterns.

Table 1. Maximum values of growth parameters recorded for four species of *Fagopyrum*.

Parameter	Species			
	F. escul.	*F. sagit.*	*F. kash.*	*F. tata.*
Total dry wt. g plant^{-1}	5.41 (10) ±1.37	6.16 (15) ±2.27	7.21 (14) ±1.49	17.51 (12) ±2.89
Root dry wt. g plant^{-1}	1 (10)	0.810 (11)	0.780 (11)	1.790 (12)
Leaf dry wt. g plant^{-1}	1.60 (9)	1.70 (10)	3.10 (10)	3.39 (12)
Dry wt. of branches g plant^{-1}	5.14	4.70 (10)	5.90 (10)	9.94 (12)
Percent moisture content plant^{-1}	84.48 (5)	85.78 (6)	84.69 (5)	87.73 (5)
Leaf area cm^2 plant^{-1}	250 (7) ±45.28	321.51 (11) ±47.15	483.57 (10) ± 87.40	695.81 (12) ± 87.90
Height cm plant^{-1}	104.00 (9) ±6.44	109.15 (14) ±8.19	110.40 (11) ±8.03	143.40 (14) ±3.21

Figure in parentheses represent growth period in weeks.

Material and methods

Seeds of the four species of *Fagopyrum* viz. *F. esculentum, F. sagittatum, F. tataricum* and *F. kashmirianum* were separately sown in beds (3 × 1 m) randomised into three blocks for two successive generations i.e. 1980 and 1981. The distance between the rows was 10–15 cm and within the rows the seeds were sownt at a distance of 5 cm. The seeds were sown at a depth of 5–7 cm. Soil moisture levels were generally maintained above 50 % of field capacity. To support optimal growth, soil dressing of fertiliser was applied twice, i.e. a week prior to sowing and at 4 weeks growth. The doses of the fertilizer applied were as follows: N 57 kg/ha, P 38 kg/ha and K 40 kg/ha. The experiment was terminated at 15 weeks growth.

At each weekly interval 5 plants were sampled at random. Leaf area was estimated gravimetrically by the method described by Šesták *et al.* (1971). For the estimation of dry weight the fresh material was dried in an oven at 70°C for 48 hours. Different growth parameters were computed on the basic of formulae described by Evans (1972) and Hunt (1978). For finding net assimilation rate on leaf dry weight basis formula of Blackman and Black (1965) was used. For finding leaf area partitioning coefficient formulation of Potter and Jones (1977) was followed.

Results and discussion

Maximum dry weight, leaf area and height were attained relatively earlier in *F. esculentum* than in the other three species, among which maximum values for these parameters were attained much later in *F. tataricum* (Table 1, Figs. 1 and 2). The dry weight was found to be closely related to leaf area, thus reflecting the influence of the size of the assimilatory apparatus in determining the dry matter production.

The higher dry matter production in *F. tataricum* is commensurate with the highest leaf area in this species. It is obvious that *F. tataricum* possesses a higher productivity potential due to its greater accumulation of total phytomass and its partitioning into different plant parts. A considerably larger proportion of the dry weight was partitioned into the top parts than into roots in plants of each of the four species, making them succeptible to lodging.

Table 2. Maximum values of some growth analysis parameters recorded for four species of *Fagopyrum* (For abbreviations see the text).

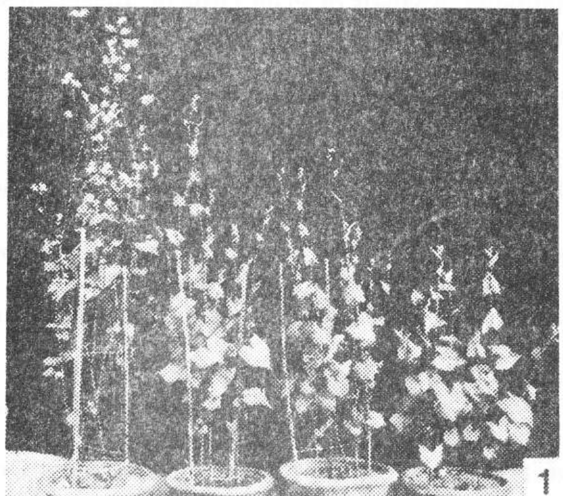
Parameter	Species			
	F. escul.	*F. sagit.*	*F. kash.*	*F. tata.*
NAR $mg cm^{-2} week^{-1}$ (leaf area basis)	13.87 (6–7)	9.41 (4–5)	8.42 (6–7)	11.37 (10–11)
NAR $mg\ mg^{-1} week^{-1}$ (leaf dry wt. basis)	5.33 (6–7)	2.92 (6–7)	2.05 (3–4)	2.51 (5–6)
LAR $cm^2 mg^{-1}$	0.213 (3–4)	0.129 (5–6)	0.219 (4–5)	0.197 (3–4)
LWR $g\ g^{-1} week^{-1}$	0.646 (3–4)	0.650 (3–4)	0.636 (3–4)	0.596 (3–4)
RGR $g\ g^{-1} week^{-1}$	1.86 (3–4)	1.37 (3–4)	1.30 (3–4)	1.70 (4–5)
RGR Roots	2.24 (6–7)	1.61 (6–4)	1.31 (4–5)	1.90 (4–5)
RGR Leaves	1.28 (3–4)	1.36 (3–4)	1.23 (3–4)	1.48 (5–6)
LAER $cm^2 cm^{-1} week^{-1}$	1.26 (2–3)	1.70 (4–5)	2.05 (3–4)	1.25 (4–5)
LAPC $cm^2 week^{-1}/mg\ week^{-1}$	1.350 (2–3)	0.181 (4–5)	0.436 (3–4)	0.228 (3–4)
BMD $g\ week^{-1}$	7.53 (9–10)	6.82 (10–11)	8.04 (10–11)	17.07 (12–13)
LAD $cm^2 week^{-1}$	219.99 (7–8)	311.31 (10–11)	456.49 (10–11)	659.74 (11–12)

Figures in parentheses represent growth interval in weeks.

Maximum recorded value for net assimilation rate (NAR) and relative growth rate (RGR) was found to be higher in *F. esculentum* as compared to the other three species; among which *F. tataricum* possessed higher values for NAR and RGR than in *F. sagittatum* and *F. kashmirianum* (Table 2). NAR was found to be closely related to RGR as reported earlier (Singh and Singh, 1982). The RGR of the leaves becomes important as it is the determinant of the time taken for a crop to develop its light intercepting canopy (Evans, 1976). Generally *F. tataricum* and *F. esculentum* possessed a higher RGR of leaves and roots as compared to the other three species. The ratio of photosynthesising to respiring material i.e. leaf area ratio (LAR) was found to be much lower in *F. sagittatum*, however, the ratio of leaf dry weight to whole plant dry weight i.e. leaf weight ratio (LWR) was found to be slightly lower in *F. tataricum* as compared to the other three species.

Leaf expansion per unit dry weight per unit time i.e. leaf area partitioning coefficient (LAPC) was found to be lower in *F. sagittatum*, *F. kashmirianum* and *F. tataricum* which suggests that there is more dry matter available for supporting leaf area expansion in these species. *F. sagittatum* and *F. kashmirianum* possessed a higher leaf area expansion rate (LEAR) compared to that in *F. esculentum* and *F. tataricum*.

Fig. 1: Plants of four species of *Fagopyrum* grown in pot culture. From left to right are arranged pots with plants of *F. sculentum*, *F. sagittatum*, *F. kashmirianum* and *F. tataricum* (photographed at eight weeks growth).



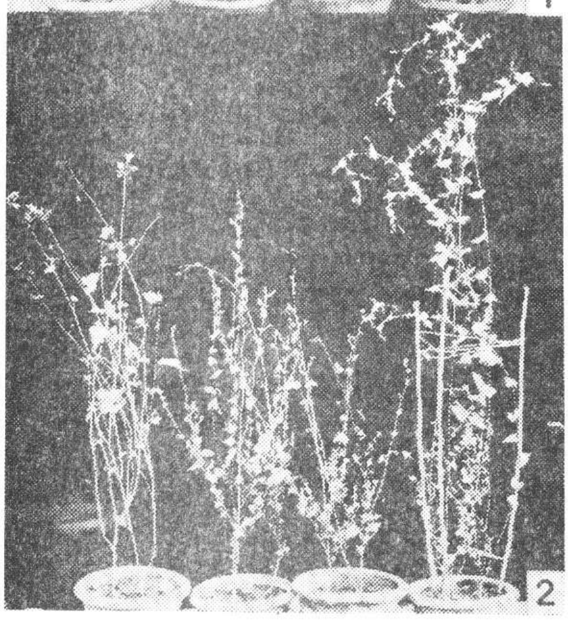


Fig. 2: Plants of four species of *Fagopyrum* grown in pot culture. From left to right are arranged pots with plants of *F. esculentum*, *F. sagittatum*, *F. kashmirianum* and *F. tataricum* (photographed at sixteen weeks growth).

Biomass duration (BMD) i.e. the dry matter production of crop's growing period and leaf area duration (LAD) i.e. the leafiness of crop's growing period was found to be maximum in *F. tataricum* owing to its longer growth span. However, *F. esculentum* attained the maximum values for BMD and LAD at an eralier stage due mainly to its quick growing efficiency as compared to the other three species. LAD thus appears to effectively determine the overall photosynthetic potentiality of the species and inturn determines BMD.

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Izvleček

Analizirana je bila rast štirih vrst rodu *Fagopyrum. F. esculentum* doseže največjo težo sušine, največjo listno površino in višino rastlin preje kot ostale tri vrste, medtem ko doseže *F. tataricum* maksimalne vrednosti teh parametrov najkasneje. Kot kaže, ima *F. tataricum* največji potencialno možen pridelek zaradi dolge življenjske dobe. *F. esculentum* ima višjo stopnjo neto asimilacije in relativne rasti. Trajanje biomase in trajanje listne površine sta največji pri tatarski ajdi, čeprav pri obojem doseže maksimalne vrednosti najpreje navadna ajda.

Fagopyrum 7 (1987): 13–15

Improvements in buckwheat *(Fagopyrum esculentum* Moench) micropropagation procedures

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Abstract

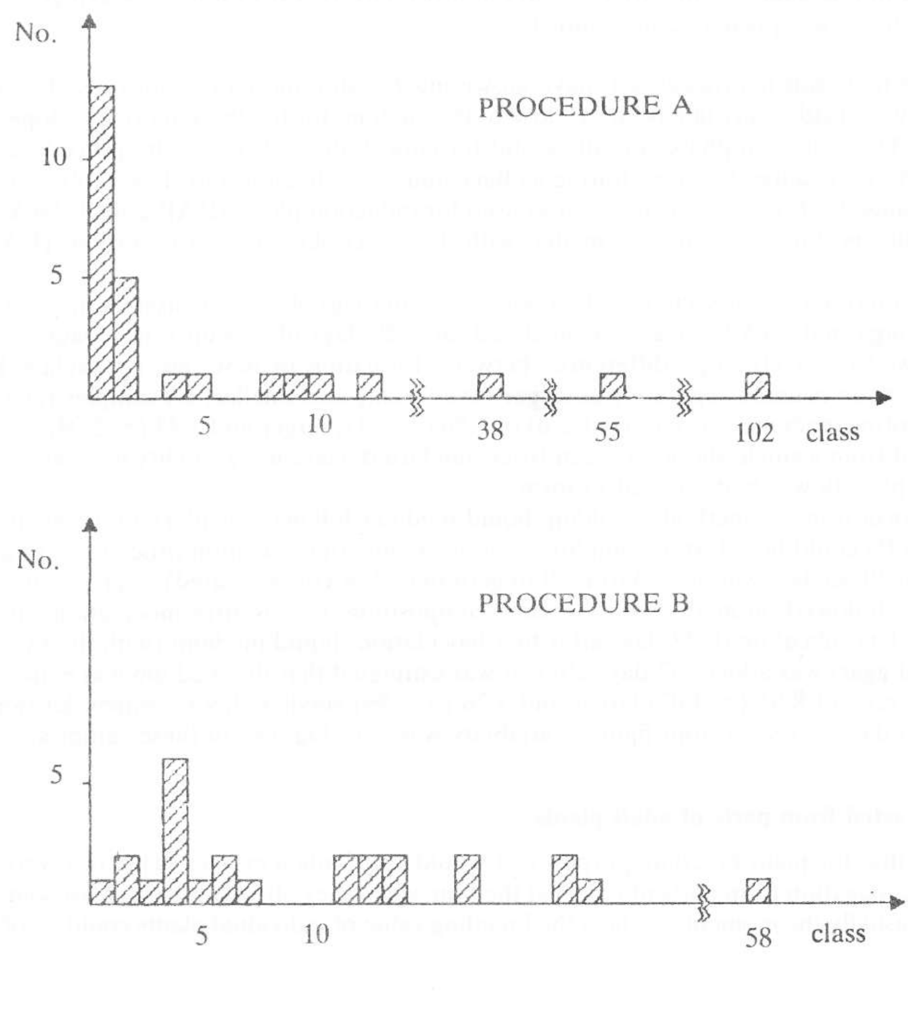
With buckwheat micropropagation started from seed, experiments were focused on radicula removement 6 days after in vitro germination followed by successful axillary bud induction, subculturing of single shoots and addition of liquid media instead of subculturing. Cutting of adult plants and induction of young shoots followed by inoculation of young inflorescences, could be a method for successful induction of micropropagation started from adult plants.

Introduction

In vitro procedures for buckwheat micropropagation have been reported in several papers (see references Yamane, 1974; Nešković et al., 1986; Bohanec, 1986). In the work presented, attention was focused on:

- improvements in procedure when micropropagation is started from seed,
- attempts to induce micropropagation from phenotypically determined adult plants.

Figure 1:



Material and methods

Buckwheat varieties »Darja« and »Siva« were used; seeds were harvested less than 1 year before sterilisation procedure. Plants from which parts were taken were grown under open field conditions.

Basal medium composition consisted of MS macro and micro elements (Murashige and Skoog 1962), 3 % sucrose, 0.6 % agar and (in mg/l): thiamine 2, pyridoxine 1, nicotinic acid 1, m-inositol 100, casein hydrolysate 2000. PH was adjusted before autoclaving to 5.7. Media were autoclaved for 15 min. at 121 °C and 15 PSI. Cultures were maintained under fluorescent lights with a day length of 16 hours.

Results

A. Procedures started from seeds

Since micropropagation is a final step also for other in vitro procedures some experiments were designed to optimise micropropagation stages.

It has been suggested earlier (Bohanec 1986) that when micropropagation is started from dehulled seeds, radicula should be removed after a few days and the rest of the plantlet should be placed on the medium to ensure close contact between the medium and shoot apex and so stimulate faster axillary branching. Data from experiment 1 (buckwhet variety »Darja«) show the differences in axillary bud formation in the treatments when radicula is not (A) and when it is (B) removed.

Experiment 1: Basic data and timetable

Basal medium, BAP 2 mg/l, IAA 0.2 mg/l

	procedure A	procedure B
No. of seeds incoluated	30	30
No. of ungerminated, albino or contaminated samples	3	4

In procedure B, radicula were removed 6 days after inoculation and the remaining plants placed on fresh medium with the same composition. Axillary buds were removed and weighted after 30 days from first innoculation in procedure A and after 16 days in procedure B. Fresh weight of axillary buds grouped in classes of 0.015 g is presented in Figure 1.

It can be seen that buds in procedure B have grown much faster and more uniformly. It was noticed that the apex grew coincidentally in a position close to the medium for the three more developed samples in procedure A. The induction phase was successful for almost all seeds grown by procedure B.

The media and procedures for subculturing axillary buds have been tested. It was observed that on media with unchanged cytokinin concentration as used for induction phase (BAP 2 mg/l, IAA 0.5 mg/l) more basal callus is formed than on media with lower citokinine concentration (BAP 1 mg/l, IAA 0.5 mg/l).

The propagation rate from dissected single shoots (2–3 cm long) placed on basal medium supplemented with BAP 2 mg/l and IAA 0.5 mg/l was analysed after 28 days of subculturing. Data of 30 shoots subcultured showed relatively large differences between formation of new, mostly axillary branches. New shoots have been counted separately as larger (over 2 cm) and smaller, on samples ready for placement on the rooting medium. An average ($\pm\ \delta$) of 3.96 ($\pm$ 2.33) larger and 1.43 ($\pm$ 2.08) smaller buds have been formed from a single shoot. As seen from standard deviation, variability was very big in both classes. In 9 samples, flower buds started to form.

Instead of subculturing, a method of adding liquid medium following axillary bud formation (as in exp. 1 procedure B) could be a further simplification of the micropropagation procedure. In an experiment started with 30 seeds – variety »Darja« (9 ungerminated or contaminated) – procedure B described in exp. 1 was followed on media with the same composition. 6 days after inoculation, the radicula was cut and plantlets subcultured. 28 days after first inoculation, liquid medium (with the same composition but without agar) was added. 37 days after, it was estimated that the medium was exhausted. The result was an average of 8.91 ($\pm$ 9.03) larger and 5.76 ($\pm$ 7.99) smaller shoots, which developed from single seeds in 65 days. As seen from figures variability was very big also in these samples.

B. Procedures started from parts of adult plants

It was estimated that for plant breeding purposes, it would be of much greater value if it were possible to induce micropropagation from parts of plants at the time when they already have at least some ripened kernels, which is usually the moment at which the breeding value of individual plants could be observed.

At the time of ripening, buckwheat plants have only a limited number of green organs from which micropropagation could be started and even when they exist, it has been found very difficult to sterilise them. An attempt to use stem and leaf petiole cuttings failed because 99 % of inoculants have been contaminated.

A method of inducing new shoots from ripening plants was tested. Plants were cut to about 10 cm above ground, plants were transplanted to pots and well wetted. In 50 % of such plants new shoots and inflorescences appeared.

It had been estimated earlier that inflorescences would be the best organ for in vitro bud induction in buckwheat.

Several concentrations of NaOCl as sterilising agent were tested. The buckwheat variety was »Siva«. A treatment of 10 min. in 5 % NaOCl (with a few drops of surfactant Tween 20) followed by 3 rinses in sterile water was found satisfactory, since about 50 % of inocculums were not contaminated and about 30 % of those produced adventive or axillary shoots. In this case, the shoot induction medium consisted of basal medium supplemented with BAP 2 mg/l, KIN 2 mg/l and IAA 0.5 mg/l. The following micropropagation stages were the same as when started from seeds.

Discussion

Since micropropagation is the basic tissue culture method, the experiments presented could help in optimising conditions for in vitro growth of buckwheat.

The preserving of valuable genotypes with known morphological characteristics by successful inoculation could enable transfer of cloned plantlets to field for controlled pollination, which could be the first use of buckwheat tissue cultures for breeding purposes. Certainly a real advance in stabilising plant characteristics can be expected only from dihaploid plants, which is the current research in some laboratories, as has been reported (Adachi, 1987).

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Izvleček

Izboljšave postopkov za mikropagacijo ajde *(Fagopyrum esculentum* Moench)

Za optimizacijo metode mikropropagacije ajde začete iz semena je bila preizkušena metoda odstanitve radikule 67 dni po *in vitro* kalitvi, čemur je sledilo uspešno aksilarno razraščanje, preizkušana je bila hitrost razraščanja aksilarnih poganjkov začetih iz posameznih poganjkov ter nadomestitev subkultiviranja z dolivanjem tekočga medija. Vpeljana je bila metoda temelječa na vzbuditvi rasti mladih poganjkov iz odrezanih starejših rastlin; iz novo nastalih socvetij je uspelo inducirati in vitro mikropropagacijo.

Fagopyrum 7 (1987): 16–18

Light and temperature dependence of net photosynthesis for buckwheat

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Abstract

The dependence of net photosynthesis on light and on temperature was measured and analysed for the diploid cv. »Siva« variety of buckwheat.

Introduction

Many external factors influence CO_2 exchange between plant and environment. As a photochemical process net photosynthesis is directly dependent upon the availability of radiation. On the other hand the dark reactions of photosynthesis and respiration are biochemical processes limited especially by temperature. In spite of great importance of determining the influence of light and temperature on net photosynthesis for buckwheat, there are only a few works dealing with this problem (Akberdina 1970, Akberdina 1971, Populidi 1976, Kajfež-Bogataj and Gaberščik 1986).

Material

We estimated the effects of light and temperature on CO_2 exchange for buckwheat variety diploid cv. »Siva«. Plants were sown on 15 July and grown outside for 50 days. Two days before measurement they were put in the climate chamber in phenological stage of fully blossom. Regarding the prevailed weather, plants were adapted to rather high daily light intensities (daily sum of global radiation around 5 kWh/m^2)· and to mean daily temperatures around 170°C.

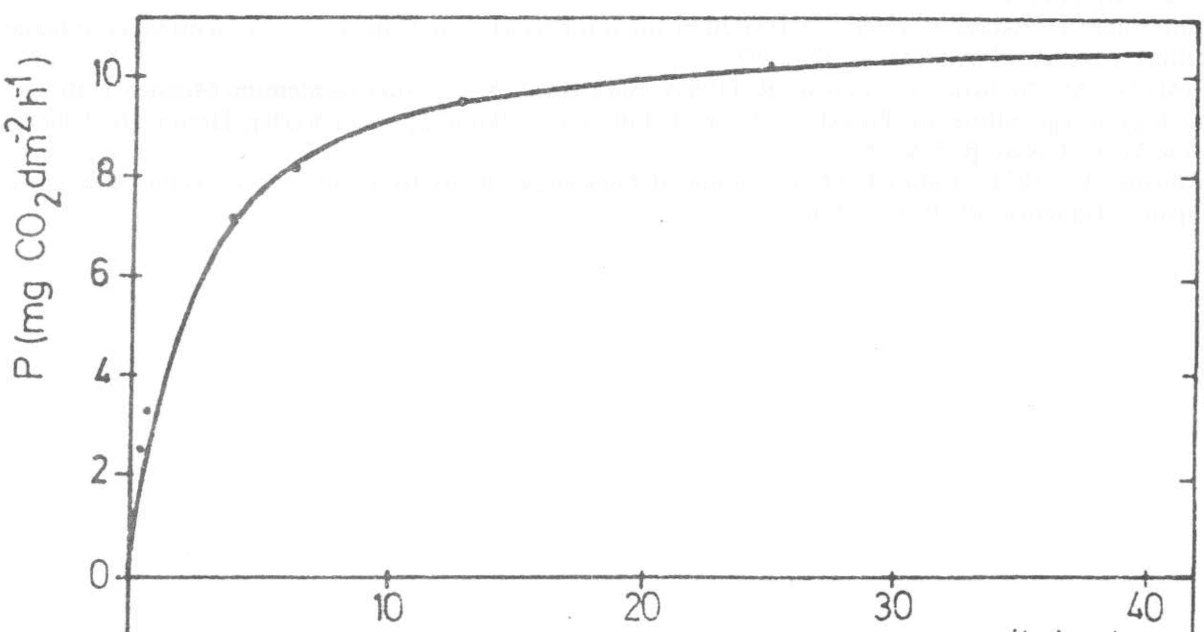

Fig. 1: Light dependence of net photosynthesis in cv. »siva« (20°C and relative humidity 70 %).

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Methods

Dependence of net photosynthesis upon light intensity was measured using Infrared gas analyser (IRGA, Type 225/2, Hoddeson, England). Artificial PAR radiation was simulated by Sylvania. GROLUX F 14 TB, Denvers, USA and additional 1500 W lamp – TEZ Tesla, Yugoslavia) and measured by Quantum-Radiometer-Photometer (LI-COR, LI-185, Lambda, Nebraska, USA). Temperature in climate chamber was kept constant 20°C, which is very close to optimal temperature for net photosynthesis. Relative humidity was kept at 70 % and we used air with 350 to 400 ppm CO_2. First we measured leaf respiration in the dark and latter net photosynthetical activity at different light intensities. We raised (approximately doubled) the light intensity in time interval of half an hour from 200, 400, . . . to 40 000 lux.

The next step was determining the net photosynthesis relation to temperature. Leaf temperatures were measured by teletermometers (YSI, Model 44 TZ, Yellow Springs, USA). Artificial PAR radiation was simulated and kept constant at 25 000 lux (475 $\mu Em^{-2}s^{-1}$). Relative humidity was from 60 to 90 %. We raised temperature at the rate 5°C per hour. The low temperature and the high temperature interval were examined separately within period of 24 hours.

Results and discussion

The light dependence of net photosynthesis at optimal temperature (20°C) is given on Fig. 1. The compensation light intensity for buckwheat is rather low, bellow 500 lux (10 $\mu Em^{-2}s^{-1}$). Once the compensation point has been passed, CO_2 uptake increases rapidly till the light saturation point is reached between 35000 and 40000 lux. We can se that buckwheat net photosynthesis is not very efficient and thus the light dependence curve saturates at rather low intensity, being typical for C_3 plants. Maximum rate of CO_2 uptake at optimal temperature and saturated light intensity was close to 11 mg CO_2 dm^{-2} $hour^{-1}$. Assuming the plants were healthy and in optimal stage of development regarding net photosynthesis capacity mentioned rate should be close to maximal CO_2 exchange capacity for cv. »Siva« variety. This study corresponds to results reported by Akberdina (1971).

The temperature dependence of net gas exchange (Fig. 2) shows three cardinal points: temperature

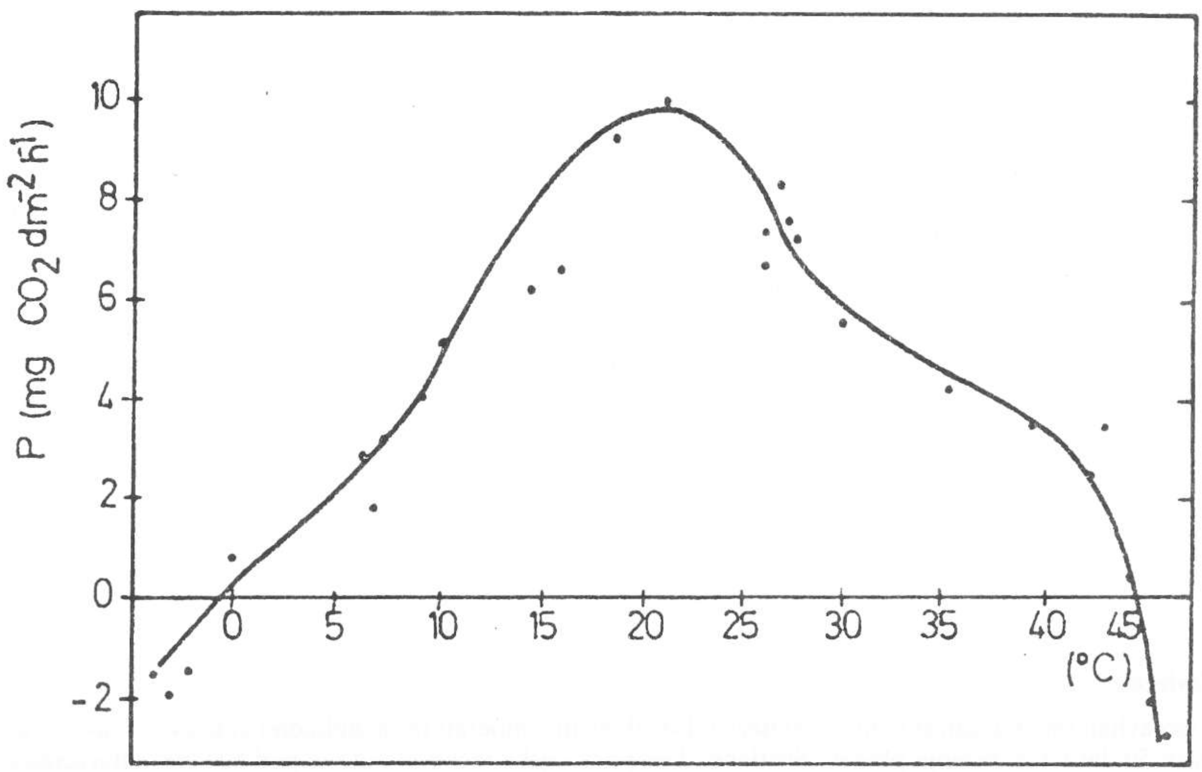

Fig. 2: The temperature dependence of net photosynthesis for cv. »siva« (light intensity 25 000 lux, relative humidity 70 %).

minimum for positive net, photosynthesis lies slightly bellow O°C, which is relatively very low temperature in comparison with some other C_3 grain crops. Optimal range of temperature in which net photosynthesis is more than 90 % of maximum obtainable lies between 17° and 24°C. This interval is a bit narrower than in previous investigations (Kajfež-Bogataj and Gaberščik 1986). Such differences are normal and depend on ecological conditions of the plant (Larcher 1980). The high temperature limit for net photosynthesis or the heat compensation point is reached at 45°C. We can see that positive net gas exchange is measured over the wide range of temperatures which shows that cv. »Siva« variety is very well adapted to different thermal conditions which can appear in the environment.

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Izvleček

Ugotavljali smo odvisnost neto fotosinteze od svetlobe in temperature za diploidno ajdo cv. »siva«, v starosti 50 dni v fazi razvoja plodov. Svetlobna kompenzacijska točka za ajdo je pod 500 lux, saturacijska pa med 35000 in 40000 lux, merjeno pri optimalni temperaturi 20°C, minimalna temperatura za pozitivno neto fotosintezo je malo pod o°C, optimalni interval med 17° in 24°C, ter maksimalna temperatura pri 45°C.

Studies on buckwheat improvement[1]

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Buckwheat, besides a subsidiary food grain crop has also come into prominence as an exceptional plant containing protein of very high biological value. Buckwheat proteins are rich in many amino-acids as compared to other plant proteins, and are almost equal to animal proteins. In country like India, where people are largely vegetarial, buckwheat offers a great potential.

At present, buckwheat does not form part of diet of the majority of population and its use is restricted only to the people inhabiting the valleys in Himalayas where it is widely grown as a summer crop.

In the upper gangetic plains, it is also consumed in a variety of preparations especially on religious occasions after observing holy fast. It is still not grown as a regular crop. This is primarly due to the unsuitable climatic conditions in the plains for the crop and unremunerative returns. There is also lack of adequate planting material, particularly of the improved lines.

Considering the potential of the crop, a programme of work on buckwheat was undertaken at NBRI, Lucknow. The objectives were:

(I) Developping agro-techniques for buckwheat cultivation and
(II) Selection and evolution of new genotypes suitable to north Indian Plain.

Cultural Studies

The cultivation of buckwheat is restricted and mostly confined to the cool moist and temperate regions in the interior of Himalayas, ranging up to altitudes of 2000–12000 ft. However, preliminary observations have indicated that though buckwheat requires a moist and cold climate, it can also be successfully grown as a rabi season annual on the dry but well drained sandy and sandy loam soils of the northern plains, where day temperature does not exceed above 20°C from 15th December to 30th January. Buckwheat can be sown between 1st November to 15th November, and harvested in February.

The studies were undertaken for spacings and application of fertilizers. Plants were spaced 25–30 cm apart between rows and 10–15 cm from plant to plant. Seeding rate was 60 kg/ha. Fertilization was given at the rate of N 60 kg/ha, P_2O_5, 50 kg/ha, and K_2O 80 kg/ha and a total of 4 irrigations during the vegetative development period of 75 days were given. Observation were recorded on the effect of fertilizers on the height of plant, no. of flower cluster/plant and yield per 100 plants.

Application of urea resulted in an increase in height (4.03 %); no. of flower clusters (21.9 %) and in the yield of seed (5.8 %). Plants treated with superphosphate, reduced the height of plants (5.94 %) and seed weight (6.0 %) but increased (14.05 %) the no. of flower clusters. Muriate of potash had no significant effects either on height of plant and no. of branching or yield of grains.

Combined fertilizes gave better results than the ones, treated with urea, P_2O_5 and H K_2O, individually. There was an increase 3 %, in height of plants, 25.2 % in no. of flower clusters and 3.8 % in yield of grains.

Genetic improvement

A collection of 15 lines representing 6 varieties of buckwheat has been built up. Most of plants are acclimatized and are growing well.

Cytological analysis of different lines of *F. esculentum* indicated that all of them were diploids. In order to induce genetic diversity, some experiments to raise polyploids and induce mutations were also performed.

Polyploidy

In order to increase seed size and protein content, colchiploidy in three buckwheats was attempted and was successful. All the autotetraploids were cytologically studied. Meiotic analysis has indicated that they have irregular meiotic behaviour. Chromosome configurations like multivalents, bivalents and univalents have been observed occuring in variable frequencies at meta. I. The subsequent course of meiosis was also found irregular. Due to disturbances of genetic balance. There was reduction of pollen/ovule fertility and hence the seed setting in the colchiploids was low.

The C_3 generation of buckwheat polyploids are under study.

Studies to work out the co-relation ship between chromosome configurations chiasmata frequencies and seed set in the induced autotetraploid lines , are in progress.

[1] Presented at 3rd workshop of All India Coordinated Project on underutilized and unexploited plants, held at NBPGR, New Delhi, June 30 and July 1, 1986.

Mutations

Through X-ray irradiation, large number of phenotypic variations have been recorded within the mutation progenies. They are being assessed for their cytogenetical characteristics.

So far, 6 desirable lines with regards to their adaptability to local conditions, yield and quality characters, have been made. Their performance are under study.

Izvleček

V Indiji, kjer se ljudje prehranjujejo predvsem vegetarijansko, je ajda s svojimi kakovostnimi beljakovinami zelo pomembna potencialna poljščina. Za sedaj jo pridelujejo predvsem kot poletno poljščino v dolinah Himalaje. Na zgornjih gangeških planotah jo tudi uporabljajo v povezavi s postom. Na planotah jo lahko pridelujejo v zimskem času; sejejo jo v začetku decembra in žanjejo februarja. Opisani so poskusi pridelovanja in žlahtnjenja ajde (poliploidija, izzvane mutacije).

Aphelinus kashmiricus Hyat — a parasite of *Aphis gossypii* Glover (Melon Aphid) in Kashmir

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Four species of buckwheats viz. *Fagopyrum esculentum*, *F. tataricum*, *F. sagittatum* and *F. kashmirianum* are cultivated in some remote and high altitude areas of Kashmir mainly because of nutritive value.

In Kashmir melon aphid-*Aphis gossypii* Glover (Homoptera: Aphididae) happens to be a serious pest of buckwheats causing substantial damage to plant through sucking sap. The infested leaves show curling, become wilted and finally dry up. *Aphelinus kashmiricus* Hyat (Hymenoptera: Aphelinidae) an endoparasite was reared from the adults of *Aphis gossypii*. In the laboratory parasites were obtained from field collected melon aphids infesting buckwheat plants. Bagat (1985) has recorded *Aphelinus kashmiricus* from *Aphis gossypii* attacking *Zennia elegans* in Kashmir.

Reference

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Study on the development and contributions of different plant organs to buckwheat dry matter production

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Abstract

The field experiment was accomplished at Ljubljana in 1985 to study development and dry matter contributions of buckwheat roots, leaves, stems, flowers and grains to total dry matter production for cv. »Darja« during the growing period (18/07 – 07/10) through 7 successive samplings. Changes in dry weight of buckwheat plant organs and their relative contributions during the growth period are analysed and discussed.

Introduction

The growth rate of plant and of its organs during its development is variable. The increase in plant biomass is not the same in different phases of its growth. Knowledge of development characteristics of buckwheat plant is still incomplete in spite of several studies (Pauševa 1970, Ali-Khan 1973, Tsuzuki et al. 1983, Kajfež-Bogataj and Knavs 1985, Farooq and Tahir 1987). In order to reveal a more complete picture of the growth of different plant organs various growth analysis techniques can be applied (de Vries and van Laar 1982, Tsunoda 1983) based on field experiment. One of such approaches is presented in this work.

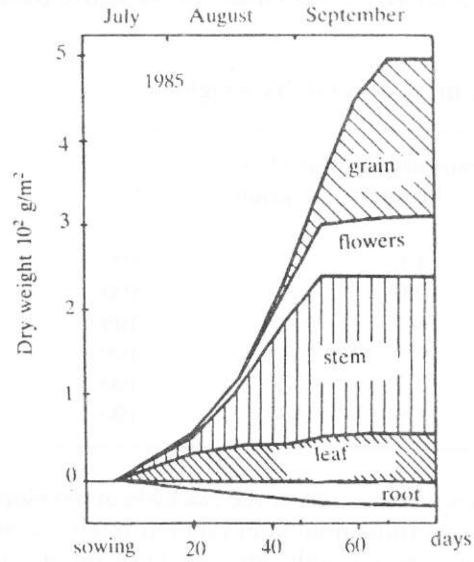

Fig. 1: Changes in dry weight of buckwheat plant organs during growth period.

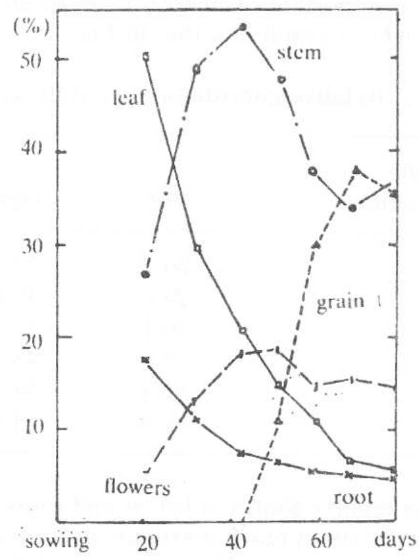

Fig. 2: Relative contributions of buckwheat plant organs during growth period.

Material and methods

Diploid cv. »Darja«, plants were used in experiment. The buckwheat seeds were obtained from Agronomy Department, Biotehnical faculty, University E. K. Ljubljana. The plants were grown on the experimental field near Ljubljana from July 18 to October 7 in 1985. Fertilizer application rate was at 40 kg N, 40 kg P_2O_5 and 40 kg K_2O per hectar. Planting density was 200 plants per m^2. One plot was 60 cm × 40 cm and consisted of two rows. The experiment was conducted in four replications.

During the growing period, sampling was carried out 7 times. The interval between sampling was 8–11 days (20, 31, 42, 50, 58, 66 and 76 days after germination, which was on July 24). Plants were collected together with roots and divided into roots, leaves, stems, flowers and grains. Dry weights were measured after drying 4 days at 60°C and 1 hour at 105°C before weighting.

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Experimental results and discussion

The dry weights of different plant organs at various stages of growth development are presented in Table 1:

Table 1: Dry weights of different buckwheat organs in grams per m^2 ground

days after germination	leaf	stem	root	flowers	grain	total
	dry weights (g/m^2)					
20	30.8	16.4	10.6	2.8	/	60.6
31	40.7	67.2	15.6	13.8	/	137.3
42	54.6	145.6	21.0	49.9	/	271.1
50	57.8	187.0	26.2	71.3	43.8	386.1
58	53.7	179.2	25.9	69.1	141.7	469.6
76	28.2	183.7	27.7	73.2	179.2	492.2

After germination the exponential growth phase began until 30th day when all the photosynthetic products were invested in the formation of new roots, leaves and stems. From 30th to 50th day growth rate remained nearly constant, the photosynthetic products being invested more in maintenance of the plant and less for expansion of for instance leaf area. After 50th day plant turned from the vegetative phase into the reproductive phase. The quantity of leaves is decreased, the quantity of stems and roots is stagnated but flowers and grains begin with further growth (Fig. 1).

During the development of a buckwheat plant, the partition of the photosynthetic product among its organs is important (Table 2). If organ growth is expressed as a relative contribution to the entire plant dry weight, a graph like that in Fig. 2 is obtained.

Table 2: Relative contributions of different buckwheat organs in % of total dry weight

days after germination	leaf	stem	root	flowers	grain	total
	relative contributions to total (%)					
20	50.7	27.0	17.7	4.6	/	100
31	29.6	49.0	11.4	10.0	/	100
42	20.1	53.7	7.8	18.4	/	100
50	15.0	48.4	6.8	18.5	11.3	100
58	11.4	38.2	5.5	14.7	30.2	100
66	6.6	34.0	5.4	15.5	38.5	100

The relative shares of leaves and roots decrease exponently with time during the buckwheat development. The stems reach maximum percentage near 40th day after germination, later on their relative contribution decreases. The relative contribution of flowers increases till 50th day and later on slowly decreases while grains develop. The relative dry weight of grains to total dry weight show an exponental increase and in the end of growth period gives a crop index about 36 %.

Conclusions

In buckwheat the partitioning of assimilates to different organs and especially the partitioning of dry matter between grains and vegetative parts is of great importance. About the internal control of distribution of assimilates in buckwheat still little is known. This implies that more data about dry matter distribution have to be collected experimentally. Experimental data should give a certain key for dry matter distribution among plant organs. Such a key would be characteristic for studied variety, although it may be different for different cultivars.

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Izvleček

Opisani so rezultati, dobljeni na osnovi poljskega poskusa z genotipom »Darja« v Ljubljani v letu 1985 (Setev 18/07 – žetev 07/10). Z zaporednimi sedmimi odvzemi vzorcev smo ugotavljali rast in razvoj posameznih rastlinskih organov (korenin, listov, stebel, cvetov in zrnja). Prikazana sta poteka absolutnih in relativnih prispevkov mase posameznih organov k skupni masi ajde tekom rastne dobe ter opisane njune glavne značilnosti.

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The information

about the General Assembly of IBRA members which took place during the 3rd International Buckwheat Symposium, Puławy 7–12 of July, 1986.

On the meeting discussed the rules of IBRA, activity of the Association in the future, edition of New sletter »Fagopyrum«, continuation of agroecological study, organization of next symposium and at the end of the meeting it was elected the new IBRA Executive Committee.

1. All members of Association agree with rules which were accepted on IBRA general assembly in Miyazaki, Japan, during the 2nd International Buckwheat Symposium in September 1983.

2. The activity will be developed mainly in the following fields:

a) Edition of New sletter Fagopyrum (Prof. Dr. I. Kreft and his coworkers). Publishing and editing is autonomous, but proposal and advice of IBRA executive committee are taken into account. The free copies of Fagopyrum are distributed to scientists and members of IBRA. »Fagopyrum« is very important newsletter because it is possible to present the newest information about various fields of buckwheat studies. The articles, announcements, informations can be in English or in other language with summary in English.

b) The agroecological studies will be continued in 1987 and 1988. Every year results will be send to the representatives of various countries.

c) The studies on the problems of buckwheat grain, groats and flour quality. Special group from Jugoslavia (Doc. Dr. B. Javornik), Poland (Doc. Dr. Ł. Fornal, Prof. Dr. M. Ploszyński) and Denmark (Dr. B. O. Eggum) will prepare the proposition for discussion. The proposition will be published in »Fagopyrum«. Remarks will be colleted by editorial staff of »Fagopyrum« and send to the authors. The »quality group« prepare the final conclusion and present on the 4th International Buckwheat Symposium and also in New sletter »Fagopyrum«. This group will discuss also the problems of new products prepared from the buckwheat (grains, plant, leaves, flowers, hulls).

d) Will be lead in Poland the collection of different species, varieties, cultivars or genetic lines of buckwheat. Everybody who is interested on that project can get the sample of the seeds. We ask the scientific workers who has interesting lines of buckwheat to send them to the head of the collection (Dr. Kalina Komenda, High School of Agriculture and Pedagogics, Department of Genetics, Prusa Street 12, 08-110 Siedlce, Poland). It will be also very usefull to publish the information about the different new lines of buckwheat in New sletter »Fagopyrum«.

e) It is proposition to organize two groups connected with: storage of buckwheat seeds and protection the plants against diseases and insects. We are waiting for information who is especially interested in that project and one can be organizer of the scientific workers group which will prepare the scientific papers (lectures or announcements) on the 4th buckwheat symposium.

3. The next symposium on buckwheat will be organized by USSR (Professor Dr. N. V. Fesenko, All-Union Research Institute of Grains and Legumes, Orel, p/o Strieleckoje/ in July 1989. It is also proposition that the 5th International Buckwheat Symposium will be in India in 1992.

4. The General Assembly on the session during the 3rd International Buckwheat Symposium elected the chairman, vicechairmen and other members of IBRA Executive Committee for the years 1986–1989.

The Executive Committee

Chairman	Prof. Dr. Marek Ruszkowski
Vice-chairman	Prof. Dr. Michal Ploszyński
Vice-chairman	Doc. Dr. Marian Król
The members	Prof. Dr. Krystyna Kusiorska
	Doc. Dr. Jan Mazurek
	Doc. Dr. Łucja Fornal
	Doc. Dr. Jan Szklarz
	Dr. Kalina Komenda

We are waiting for continuation of »buckwheat family« cooperation. Every problem connected with buckwheat genetics, physiology, breeding, technology of production, quality and utilization we ought to present in Newsletter »Fagopyrum« or send as a information to the IBRA Executive Committe in Poland (President of IBRA, Prof. Dr. Marek Ruszkowski, Institute of Soil Science and Plant Cultivation, Czartoryskich Street 4, 24-100 Pulawy, Poland).

For sure our Association will develop and the members will cooperate thorugh Newsletter »Fagopyrum«, Executive Committee and International Symposiums.

The best regards for all members of IBRA and whole »buckwheat family«. We are waiting for your cooperation.

Yours sincerely
Marek Ruszkowski
President of IBRA

BUCKWHEAT RESEARCH 1986

Proceedings

of the 3rd International Symposium on Buckwheat

Pulawy, Poland, 7 – 12 July 1986

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