韓作誌(Korean J. Crop Sci.) 37(1) : 86~92(1992)

Vegetable Value and Productivity of Buckwheat Seedlings

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메밀菜蔬의 生産性 및 菜蔬的 價値

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ABSTRACT : Green buckwheat seedlings have been used as a pollution free vegetable and medicinal crop for a long time. Some of the reasons are the rapid growth rate, the high protein and rutin content, and a more favorable ratio of leaf to stem than mature plants. Off-crop season cultivation techniques were developed for growing the young and green buckwheat vegetable of higher quality and yield, and for its increased value-added income. The effects of planting season, seeding rate, seed bed soil fertility and type, and seedling growth period on yield and rutin content were determined for vegetable and medicinal use. The young vegetable yields in the off season culture ranged from 2.62t/ha to 22.7t/ha. The highest vegetable yield was 22.7t/ha for 25 days old seedlings grown in the polyethylene film tunnel from March 30 to April 25, 1991 where seedling rate was 360kg/ha. Buckwheat vegetable quality and income were dependent upon planting season, seeding rate, growing duration and temperature, and facilities of raising seedlings. Protein content of buckwheat seedlings was from 21.5% to 17.2%. Rutin content of the vegetable was 53.9~31.7mg/100g for the whole plant in average. The protein and rutin content was significantly varied due to the different environmental conditions including fertility and type of seed bed soil, growing duration, temperature of the green house, and polyethylene film house and tunnel.

Buckwheat (Fagopyrum esculentum Moench) has been a favorite food and vegetable crop in Korea for a long time. Korean ancestors cultured buckwheat to use as a very important health food and a medicinal plant, and thought the buckwheat plant as a spiritual being of five directions possessing green leaf, red stem, white flower, black seed and yellow root. From old times in Korea buckwheat has been sown in substitution for the other upland crops in case of extremely dry and/or wet weather conditions as hardy plants of pseudocereal grain and vegetable. Young and green buckwheat seedlings with soft leaf flesh have been recognized as a pollution-free health vegetable and medicinal plant due to their rapid growth, higher protein content being more than 20%, rutin content being more than 50mg/100g, and a more favorable ratio of leaves to stems than mature plants. We developed off-crop season cultivation techniques for growing the young and green buckwheat veg-

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〈접수일자 : '91. 11. 12〉

etable of higher quality and yield, and for farmer's increased value added income. The objective of the paper was to introduce fresh buckwheat vegetable yield, cultural method and nutritive value. Rutin is a flavonol glycoside used as a medicine for protection and treatment of diseases of adult people and radiation diseases.

Materials and Methods

The cultural method trials for summer and fall buckwheat were carried out at the experimental farm of Crop Experiment Station, Suwon, Korea from 1989 with Sinnong 1, SinjuDaemaemil and Suwon Local varieties. For evaluation of vegetable value and productivity of buckwheat seedlings, summer buckwheat Sinnog 1 was sown by drill seeding of 15cm row width on the bed of greenhouse for the first time on December 29, 1990 and harvested on January 26, 1991. The second seeding was made on the broadcasting seedling tray for rice on January 19, 1991, and the seeding rate was 4 and 8g/tray in the greenhouse and harvested on February 11. The third seeding was made on the broadcasting seedling tray filled with upland soil and Bunong seed bed soil in the greenhouse. The seeding rate was 3g and 6g/tray. Seedling growth duration was 20, 25 and 30 days, The fourth planting was sown in the polyethylene film house on March 4 using the same methods of the third planting, and harvested on March 21. The fifth planting was sown in the polyethylene film tunnel of 120cm width. The seeding rate was 18kg and 36kg/10a which were broadcasted uniformly. Spectrophotometric asation was 20, 25 and 30 days. Rutin($C_{27}H_{20}O_{16}$) content analysis of buckwheat seedlings was made using Methanol Spectropho tometric assay method. Analysis of nutritional values were obtained from the laboratory of the Rural Nutrition Improvement and Training Center, Rural Development Administration in Suwon, Korea.

Results and Discussion

Vegetable value of buckwheat seedlings

Buckwheat seedling is digestible and tasty, and aiso rich in protein, minerals and vitamins as shown in Table 1. Twenty five days old buckwheat seedlings contained a considerable amount of protein, iron, copper, phosphorus, and vitamins as compared with older seedlings and thus is of higher value as a green vegetable.

Table 1. Nutrition value of fresh buckwheat seedlings(Suwon, 1991)

Energy	Moisture	Protein	Lipid	Carbohydrate(g)		Ash
(kcal)	(%)	(g)	(g)	Sugars	Cellulose	(g)
17	92.9	2.2	0.2	2.7	0.9	1.1

Mineral(mg)			Vitamin(mg)				
Ca	P	Fe	A(IU)	B_1	B_2	Niacin	C
44	32	0.4	543	0.04	0.03	0.7	6

※ Cultivar : Sinnong 1

Unit : kcal, %, g, mg/100g of fresh buckwheat seedlings.

Seedling age : 25 days old and grown in polyethylene film tunnel from March 30 to April 25, 1991.

Table 2. Difference in seedling weight between diploid and tetraploid buckwheat cultivars(Suwon, 1991)

Cultivar	Chromosome number (2n)	Plant height (cm)	Fresh seedling weight (g/100plants)	Fresh seedling weight (Index)	Ecological type
SinjuDaemaemil	32(4×)	15	330	135	Fall buckwheat
Sinnong 1	16(2×)	13	238	98	Summer buckwheat
Suwon Jaerae	16(2×)	13	244	100	Fall buckwheat

Particularly, leaf, stem, flower, and seed of buckwheat plant contain rutin that is used as medicine in treatment of various and radiation diseases including high and low blood pressure, glaucoma, diabetes, cancer, X-ray and other radiation diseases[3,4,5]. Rutin is a flavonol glycoside used as a medicinal agent for treatment of vascular disorders caused by abnormally fragile or permeable capilaries and radiation diseases. Rutin content of the vegetable was 69.3mg/100g of dry leaf, 17.6mg/100g of dry stem, and 46.4mg/100g of the whole plant in average. The rutin content varied significantly among different cultural conditions inable difference between the cultivars. Particularly, pericarp of the seed contained more rutin than the groats of buckwheat. There were significant differences between the seeds harvested from spring-planted and summer-planted buckwheat. Spring-planted buckwheat produced more rutin as compared with summer-planted buckwheat in Korea. There were differences in rutin content among the cultivars planted in spring and summer. The rutin content of the buckwheat groats ranged from 8.84mg to 24.77mg/100g. The rutin content of commercial buckwheat groats and flour ranged from 15.04mg to 20.92mg/100g, The rutin content of commercially dried buckwheat noodles, steamed buckwheat noodles and buckwheat cookies ranged from 76mg to 10.84mg/100g in Korea.[3,4,6]

Tetraploid buckwheat cultivar was by 35% higher in seedling weight and of better quality as compared with diploid cultivars(Table 2).

cluding soil fertility and type of seed bed, growing duration and temperature of the greenhouse, polyethylene film house and tunnel[3,4,5].

The rutin content of buckwheat grain was 21.4mg/100g for Suwon Local and 30.2-30.4mg/100g for Sinnong 1, showing a consider-

Productivity of buckwheat vegetable

The seedling yields in the off-crop season culture ranged from 2.6t/ha to 22.7t/ha and with expected gross income 5.24 to 12.50 million won/ha. The highest vegetable yield was 22.7t/ha for 25 days old seedlings grown in the polyethylene film tunnel from March 30 to April 25, 1991. Buckwheat vegetable quality and income from the cultivation were dependent upon planting season, seeding rate, growing duration, temperature during the growth period, and facilities for raising seedlings.

Optimum growing duration of buckwheat vegetable was from 20 to 30 days from planting to harvesting. Vegetable yield and gross income increased as the growing duration was extended from 20 days to 30 days as presented in Table 3~6.

Rutin content of the young buckwheat plants ranged from 31.7 to 53.9mg/100g. Protein content of the young huckwheat plants was highest in the 20 day-old seedlings with 21.5% and then decreased as growing duration became longer.

High quality buckwheat vegetable must have green an thick leaves and stems. Therefore, an appropriate level of soil fertility

Table 3. Growth, green vegetable yields, buckwheat seedlings grown on the rice broadcasting tray for rice seedlings in greenhouse, Suwon, Korea

Variety	Seeding rate (g/tray)	Seedlings/tray	Plant height (cm)	Leaves/plant	Green plant weight (g/tray)	Green vegetable yield (kg/10a)
Sinnong 1	4	117	12.5	2	125	625
	8	234	14.2	2	228	1,140

※ Greenhouse temperature : 15~25℃
Growing duration : 24 days from January 19 to February 12, 1991

Table 4. Green vegetable yields, protein and rutin content of buckwheat seedlings grown on the broadcasting tray for rice seedling in the greenhouse, Suwon, Korea.

Growing duration from planting to harvesting	Green vegetable yield (kg/10a)	Protein (%)	Rutin (mg/100g)	Remarks
20 days	631	21.5	53.9	Dry matter weight basis
25 days	893	18.0	53.8	
30 days	1,365	17.2	31.7	
Mean	963	18.9	46.5	

※ Variety : Sinnong 1, .Planting date : February 1, 1991
Seeding rate : 3~6g/tray, Greenhouse temperature : 15~30℃

Table 5. Growth and green vegetable yields of buckwheat seedling grown on the broadcasting tray for rice seedling in the polyethylene film house, Suwon, Korea.

Seeding rate (g/tray)	Seedings/tray	Plant height (cm)	Stem diameter (mm)	Leaves/plant	Leaf(cm) Length	Leaf(cm) Width	Green vegetable yield (kg/10a)
3	96	29	2.8	2.8	4.0	4.2	1,300
6	187	25	2.5	2.4	3.6	3.7	1,746

※ Variety : Sinnog 1, Planting date : March 4, 1991
Growing duration : 17 days Polyethylene film house temperature : 18~38℃

should be maintained for production of green and healthy buckwheat vegetable. Optimum seeding rate for vegetable was 30 to 40kg/ha and the optimum temperature range was 15 to 35℃ in the polyethylene film house and tunnel.

For buckwheat vegetable production it would be better to plant more densely at higher seeding rate as compared with grain production seeding rate. Optimum seeding rate for planting during the frost-free periods was 30~40kg/10a and with 2~3cm planting depth. Buckwheat-planting soil must be fertile for

Table 6. Growth and green vegetable yields of buckwheat seedling grown in the polyethylene film tunnel

Growing duration from planting to harvesting	Seeding rate (g/m²)	Seedings/ tray	Plant height (cm)	Leaves plant	Leaf(cm) length	Leaf(cm) Width	Stem diameter (mm)	Green vegetable yield (kg/10a)
20 days	18	658	23	2.9	3.7	3.7	3.5	1,100
	36	1,647	25	2.7	3.3	3.2	3.2	1,800
25 days	18	819	32	3.6	3.8	3.8	3.8	1,375
	36	1,321	33	3.2	3.9	3.7	3.7	2,270
Mean	18	739	28	3.3	3.7	3.7	3.7	1,238
	36	1,484	29	2.9	3.6	3.5	3.4	2,035

※ Variety : Sinnong 1, Planting date : March 30, 1991, Suwon, Korea
Polyethylene film tunnel temperature : 15~35℃

Table 7. Year-round culture and multiple season cropping of buckwheat vegetable in Korea

Cultivation method	Culture season Jan. Feb. Mar. Apr. May. June July Aug. Sep. Oct. Nov. Dec.
Year-round Culture	Heating ←——————→ Heatibg
Polyethylene film house Multiple season cropping	
Polyethylene filmtunnel	←——————→
Polyethylene filmmulching	←——————→
Open field cultivation	←——————→

※ Growth duration from planting to harvesting : 15~30 days

producing higher quality vegetable.

Mixed fertilizer(10-20-20) in the rate of 25~50kg/10a should be applied depending on the soil fertility just before planting to accelerate the early growth of buckwheat seedlings. Balanced application of N-P-K is needed for a healthy seedling growth. Irrigation and/or watering would be required for maintenance of optimum soil moisture to prevent any moisture stress.

For production of fresh green buckwheat vegetable, bottom part of the stem should be light green in color. The seedlings should be harvested before flowering and changing to red in color of buckwheat stem. The 15-30 days old seedlings would be used as fresh green vegetable. And 35-45 days old plants would be good for rutin production and for medicinal and tea plant because buckwheat flowers and leaves contain 80-90% of total rutin in the young buckwheat plant. From seed-bearing stage rutin content decreases dramaticaly.[3,5,7]

For production of a large amount of buckwheat vegetable, a lot of seed would be needed because of 30-40kg/10a seeding rate (Table 3,5,6). Superior cultivars for spring and summer-planting culture should be planted for two season cropping of buckwheat. And their high-yielding production techniques should be applied for production of 300kg/10a. Current grain yield level of farmers has been

90~100kg/10a for fall buckwheat in Korea. (Crop Production Year Book, MAFF, Korea, 1991)

Higher grain yield of buckwheat by two-season cropping

For best results in summer buckwheat should be planted in mid and late April, and fall buckwheat should be planted in late July being 10-12 weeks before a killing frost is expected because the crop plants respond differentially to day length and temperature and can be divided into summer buckwheat to harvest during the summer season, and fall buckwheat to harvest during the fall season.[1,2,3,4]

When summer buckwheat cultivar Sinnong I was planted on April 20, 1989 in Suwon, Korea, its highest grain yield 304kg/10a was harvested from the plot of seeding rate 4kg/10a, broadcasting and non-mulching. Buckwheat farmer grain yield level has been only about 100kg/10a. Summer buckwheat culture has been recommended to farmers in Korea (Tables 8,9). Buckwheat production income of farmers is about 150,000 won/10a, and

Table 8. Grain yields of summer and fall buckwheats(Suwon, 1989~'90)

Seeding method		Spring planting		Summer planting	
		Grain yield	Index	Grain yield	Index
Broadcasting(120cm)		198	100	86	100
Drill seeding	60cm row width	253	128	97	113
	20cm row width	262	132	148	172
	Mean	238		110	

※ Variety : Summer buckwheat Sinnong 1
Fall buckwheat Suwon Jaere

Table 9. Standard cultivation methods for grain and vegetable of buckwheat in Suwon, Korea

Use	Planting season	Seeding rate (kg/10a)	Planting density	Fertilizer application level	Weed control
Grain	Late April summer buckwheat	4~8	Drill seeding 20cm	25~50kg/10a Compound fertilizer for soybean	Alachlor Dual 100~200cc,g/10a
	Late July fall buckwheat				
Green vegetable	May~September field cultivation without heating facilities	20~40	Drill seeding 10~15cm	15~25kg/10a Culture on the fertilesoil	
	October~April polyethylene film house and tunnel culture	20~40 (6~8g/tray)	Broad-casting	15~25kg/10a Culture on the fertile soil	

thus buckwheat vegetable should be produced to increase buckwheat farmer income up to 500,000－1,000,000 won/10a, and for our health.

摘　要

최근들어 우리나라 國民의 食品消費 形態가 점차 高級化됨에 따라 메밀의 어린 植物體와 種實은 健康 別味食品의 原料로서 國內 需要量은 繼續 增加될 展望이다. 葉菜蔬用으로 利用되는 메밀의 어린 植物體는 30% 以上의 蛋白質과 500mg/100g 以上의 Rutin과 상당한 양의 미네랄, 비타민을 含有하여 端境期 栽培時 綠菜蔬의 收量은 播種量, 播種期, 栽培環境 條件에 따라서 262～2,270kg/10a로 差異가 매우 컸으며 豫想粗收益도 52.4～183.5萬원/10a이었다. 葉菜蔬用 메밀의 育苗期間을 20, 25, 30日로 하였을 경우 育苗期間이 길수록 草長, 줄기의 굵기, 잎의 수와 크기가 增大되었다. 4倍體品種 信州大메밀의 生體重은 2倍體品種 水原在來와 信濃1號에 比하여 35%가 더 무거웠으며 葉肉이 두껍고 잎이 커서 商品價値가 더 좋았다.

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