GROWING OF CABBAGE BROCCOLI IN A FILM GREENHOUSE WITH THE SOIL MULCHING AND APPLICATION OF WATER-RETAINING GRANULES

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The results of the investigations on cabbage broccoli growing in conditions of spring film greenhouse with the application of water-retaining granules Akvod and soil mulching by synthetic and organic materials are given.

Key words: *cabbage broccoli, spring greenhouse, water-retaining granules Akvod, mulching materials, black perforated polyethylene film, black agro fiber, sawdust, straw.*

Introduction. Area of protected soil under vegetable crops has been spread in recent years in Ukraine. This gives the opportunity to provide consumers with valuable vitamin production in the early spring and autumn-winter periods. The development and introduction of new, low-costly technologies have greatly increased vegetable yield capacity [1]. In the growing technology of vegetable plants, mulching is one of the most effective methods, which promotes creation of favourable temperature regime of soil and surface layer of air, conservation of soil moisture, improvement of soil physical characteristics, strengthening of its microbiological processes. The application of soil mulching accelerates growth and development of plants, increases its yield capacity. Thanks to tight fitting of mulching materials to the soil, a heavily-penetrated layer for weed shoots is created, and this negatively influences its growth. Present agro measure shortens labour costs and conserves soil nutrients, as it is proved that with the availability of 50-150 weeds per $1m^2$ of soil, from 450 to 700 kg/ha of nutrients in terms of mineral fertilizers are taken away [2]. Various materials which prevent light penetration into the soil and avert weed growth can serve as mulch [3]. Agro fiber, the polymer material, containing stabilizer, which protects it from destruction by the rays of the sun as well as from the influence of negative temperatures, passes the water and air well is an effective mulching material. The advantage of agro fiber is long-term endurance, as it can be used for about 2-4 years, which saves costs and increases the efficiency of the given kind of mulching [4]. It is determined that the best warming of soil was achieved under the transparent film, whereas the temperature of soil was somewhat lower under the peat. Higher plant yield capacity was provided while mulching the soil with the application of black and transparent film. The smoky film with the thickness of 50 mk also showed good results [5].

The lack of precipitations and the deficit of soil moisture cause the oppression of plants. Irrigation during the vegetation period can prevent destruction of plants,

though not all water, flowing into the soil, is available for plants. The considerable part of it evaporates and leaks into the soil layer unavailable for the root system of plants. To prevent water losses, absorbent-hydrogel is put into the soil [6]. Hydrogel are granules of polyacrylamide polymer, able to absorb water and dissolved in it fertilizers, which 100 times exceed granules' own weight, and then give them out to plants as required. Granules are able to absorb and retain up to 2 liters of water per 10 g of hydrogel while swelling. Hydrogel provides water to plants only in case their roots grow into the swollen granules. This is equally true if plants are grown on the pure hydrogel and it is applied as a supplement to the substrate. Just in case of germination into the gel, roots of plants can use moisture and nutrients accumulated in granules. Roots of plants germinate into the swollen granules of hydrogel usually during 1.5-2 weeks [7].

The aim of the investigations. The aim of the conducted investigations is studying the influence of film greenhouses, water-retaining granules Akvod, and soil mulching on the yield capacity and production quality of cabbage broccoli in conditions of a film greenhouse.

Methods of the investigations. The investigations were carried out in 2011-2012 on the farm "Beatrice" of the village Semikivtsi. Cabbage broccoli seedlings of Lednitska variety were grown in the seedling greenhouse with diving of seedlings into the cassettes with the size of cells 6x6 cm. Seeds were sown on the first of February, pricking out of seedlings was carried out depending on the year of investigations from 17 to 19 of February. During the growing of seedlings in the experiment the variant with the application of granules of hydrogel Akvod was studied; the granules were added in the amount 20 g per 10 kg of soil mixture. Granules were not applied in the control variant. Seedlings aged 60 days were planted in the first decade of April. Soil in the greenhouse was leveled and covered by the polymer mulching material several days before planting seedlings. The polymer mulching material was cut in strips 100 cm of width. The edges of mulching materials were placed into furrows, previously cut in the middle of row spacing, and covered by soil. Then the marking of planting space by the scheme 70x30 cm was done, and the crosswise cuts in the places of planting out of cassette seedlings were made. Covering of the soil by mulching material of organic origin (straw, sawdust) was implemented after planting. Phenological observations, biometric measurements and accounting are foreseen by methods. When the plants got technical ripeness the collection and accounting of yield was carried out [9]. Harvesting was carried out as the head were forming in accordance with demands of the current standard – "Fresh cabbage broccoli – RST USSR 1483-89" [10].

Results of the investigations. In average for the period of investigations the phase of the beginning of head formation was earlier in variants with soil mulching by the black perforated polyethylene film – 2.05, and in control variant this phase was marked – 6.05, which is 4 days later. The phase of technical ripeness was earlier in variants with soil mulching by the black perforated polyethylene film – 13.05, while in the control variant this phase was 5 days later – 18.05. The difference in the duration of interphase periods could be seen in the variants with soil mulching by black perforated polyethylene film where interphase period of planting seedlings –

the beginning of head formation lasted for 26 days, and in the control variant – 30 days, which is 4 days longer. The best yield coming was noted in the variants with mulching soil by black perforated polyethylene film – 25days, and in the control variant the yield coming continued for 28 days which is by 3 days longer.

In the phase of technical ripeness higher heads in conditions of covered soil had plants in variants with soil mulching by black agro fiber with the application of granules – 65.9 cm and by the sawdust with the application of granules – 66.4 cm, in the control variant – 49.8 cm, which is by 16.1 and by 16.6 cm less (table 1). The stem thickness in average was larger in variants with soil mulching by black agro fiber – 19.3 and 20.7 mm and by the sawdust with the application of granules – 19.3 mm, in the control variant – 17.5 mm, which is by 1.8 and 3.2 mm and by 1.8 mm less.

Table 1

Biometric and physiological characteristics of cabbage broccoli plants during the phase of technical ripeness with the application of water-retaining granules and soil mulching in the film greenhouse (Average for 2011-2012)

Variant		Height of plants, cm	Number of leaves	Stem thickness, mm	Diameter of a rosette	Area of leaves		Net productivity of photosynthesis g/м^2 per day
Mulching material	Application of granules					m^2/plant	Thous. m^2/ha	
Black agro fiber	without granules	65,0	19,3	19,3	81,	1,	50	15,1
	with granules	65,9	19,7	20,7	86,	1,	52	15,7
black perforated polyethylene film	without granules	54,2	18,1	17,8	75,	0,	44	12,6
	with granules	55,8	19,2	18,8	81, 8	0, 95	45 ,2	13,2
Sawdust	without granules	63,1	19,0	19,0	82,	0,	47	14,1
	with granules	66,4	19,4	19,3	83,	1,	48	14,2
Straw	without granules	57,2	17,6	18,1	79,	0,	42	11,9
	with granules	60,3	17,9	18,5	80,	0,	44	12,3
Without mulch	without granules	49,8	16,3	17,5	72,	0,	38	10,4
	with granules	51,0	17,3	17,9	77,	0,	41	11,4

C – control

The largest amount of leaves had plants in variants with soil mulching by the black agro fiber – 19.3 and 19.7, by the sawdust with the application of granules – 19.4, and by black perforated polyethylene film – 19.2, in the control – 16.3, which is by 3.0

and 3.4, 3.1 and 2.9 less. The diameter of a rosette greatly depends on the amount of leaves on the plant, which is proved by the correlation analysis. The strong direct connection is determined between the amount of leaves on the plant and the indicator of a rosette diameter (r=0.91). Larger indicators of the rosette diameter during the phase of technical ripeness of heads had plants with soil mulching by the black agro fiber – 81.5 and 86.3 cm and by the sawdust – 82.1 and 83.8 cm, which is by 8.7 and 13.5 cm and by 9.3 and 11.0 cm more compared with the control variant. The leaf surface area greatly depends on their amount and size, which is proved by the correlation analysis. Strong direct connection is determined between the leaf surface area and the amount of leaves (r=0.94). Larger indicators of the leaf surface area during the phase of technical ripeness of heads had plants in variants with soil mulching by the black agro fiber – 50.7 and 52.3 thousands m^2/ha, which is by 12.3 and 13.9 thousands m^2/ha more compared with the control. Strong direct correlation connection between the diameter of the rosette and the leaf surface area is determined by the analysis (r=0.89).

Larger indicators of net efficiency of photosynthesis in conditions of film greenhouses were shown by plants in variants with soil mulching by black agro fiber – 15.1 and 15.7 g/м^2 per day and by the sawdust – 14.1 and 14.2 g/м^2 per day, in the control variant – 10.4 g/м^2 per day, which is by 4.7 and 5.3 as well as 3.7 and 3.8 g/м^2 per day less.

In the clarification of the efficiency of the investigated methods' application, the most important indicator is the level of the yield capacity (table 2). The highest yield capacity both by the years and in average for 2 years of investigations was obtained in variants with soil mulching by the black agro fiber – 3.7 and 4.1 kg/м^2

and in variants with mulching soil by the sawdust – 3.3 and 3.6 kg/м^{2,} in the control variant – 2.4 kg/м^{2,} which is by 35,1 and 41.5 and 27.3 and 33.3% less.

The essence of the given difference is proved by the results of the dispersive analysis on both years of investigations. All other investigated variants also showed significantly higher yield capacity in comparison with the control variant. It should be noted that in all variants with the application of water-retaining granules the significant addition to the yield was provided in comparison with variants where granules were not applied except 2011 when the difference was not significant in the variant without mulch but with the application of granules. The strong direct connection is determined between the level of the yield capacity and the indicator of the net efficiency of photosynthesis (r=0.98). The strong direct correlation connection is also determined between the leaf surface area and the yield capacity of cabbage broccoli plants (r=0.99).

The largest average head diameter was noted in variants with soil mulching by the black agro fiber – 16.4 and 17.3 cm and by the sawdust – 15.0 and 15.3 cm, and in control variant – 12.7 cm, which is by 22.6 and 26.6% and by 15.3 and 17.0% less. Larger average weight of the central head was received in variants with soil mulching by the black agro fiber – 357 and 400 g and by the sawdust – 315 and 342g, and in control – 225 g, which is by 37.0 and 43.8 and by 10.0 and 34.2% less. By the total weight of lateral heads the advantage was noted in variants with soil mulching by the black agro fiber – 401 and 461 g and by the sawdust – 375 and 409g, and in the

control – 253 g, which is by 148 and 208 and by 122 and 156 g less. The highest percentage of marketable yield was got in variants with soil mulching by the black agro fiber – 96.4 and 97.5% and by the sawdust with the application of granules – 95.8%, which is in comparison with the control by 4.7, 5.8 and 4.1% more.

Thus, the application of water-retaining granules and soil mulching in a spring film greenhouse without heating has the significant influence on going through phenological phases, duration of interphase periods and biometric characteristics of cabbage broccoli plants during all stages of their growth and development. The highest yield capacity both for the years and in average for the years of investigations was received in variants with soil mulching by black agro fiber – 3.7 and 4.1 kg/m^2 and by the sawdust with the application of granules – 3.6 kg/m^2, and in the control – 2,4 kg/m^2, which is by 1.3 and 1.7 and by 1.2 kg/m^2 less.

Table 2

Yield capacity and qualitative indicators of cabbage broccoli production with the application of water-retaining granules and soil mulching in the film greenhouse

Variant		head (average for 2011-2012)			Total yield capacity kg/m^2			±, before cont. kg/m^2
mulching material (A)	application of granules (B)	Diameter of central, cm	Weight of central, g	Total weight of lateral, g	2011	2012	average	
Black agro fiber	without granules	16,4	357	401	3,9	3,4	3,7	+1,3
	with granules	17,3	400	461	4,3	3,9	4,1	+1,7
black perforated polyethylene film	without granules	14,3	279	331	3,3	2,5	2,9	+0,5
	with granules	14,7	305	362	3,5	2,8	3,2	+0,8
sawdust	without granules	15,0	315	375	3,5	3,1	3,3	+0,9
	with granules	15,3	342	409	3,7	3,4	3,6	+1,2
straw	without granules	14,1	262	314	2,9	2,6	2,8	+0,4
	with granules	14,5	284	339	3,1	2,9	3,0	+0,6
without mulch	without granules	12,7	225	268	2,5	2,2	2,4	–
	with granules	13,1	247	295	2,7	2,4	2,6	+0,2
HIP_{05}	A	–			0,2	0,1	–	
	B				0,1	0,1		
	AB				0,3	0,2		

C – control

The essence of the given difference is proved by the results of the dispersive analysis. In all other variants with the application of mulch the essential addition to the yield compared with the control was also provided. It should be mentioned that in all variants with the application of water-retaining granules the essential addition to the yield in comparison with the variants where granules were not applied, was provided.

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