

Effect of Row Cover Materials and Cultivars in Broccoli Production Systems

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Ajay Nair, associate professor
Kristine Lang, graduate student
Moriah Bilenky, graduate student
Department of Horticulture

Introduction

Most vegetable growers in Iowa are selling their produce through direct-to-consumer markets such as CSAs and Farmer's Markets. Broccoli is one of the crops widely sold in these markets. An important challenge in broccoli production is the intensive use of pesticides (conventional and organic) to manage pests such as cabbage loopers, imported cabbage worm, flea beetles, and cabbage aphids that cause immense damage by direct feeding and defoliating the plant. OMRI-approved organic insecticides are expensive, require frequent re-application, and often fail to suppress these pests.

An approach being used is row cover materials that provide dual benefit of extending the growing season and integrated pest management. Many conventional and sustainable growers use spun-bond polypropylene row covers (Agribon, Reemay) to insure early harvest and exclude pests. But they can overheat plants and must be pulled off by early summer, leaving the crop exposed to pests. For broccoli and other cole crops, this unprotected period can last for 4-6 weeks, during which pesticides are sprayed—often ineffectively—against insects and disease transmission. Growers need a robust row cover material that can stay on longer, provide greater air movement, and can be re-used many times. This study evaluated new nylon mesh row cover material (Protek net) that could be used to potentially extend the

growing season and protect plants from insect pests.

Spring-planted broccoli is harvested mid-to-late June in Iowa and it often is challenging to preserve the quality of broccoli in the open field. Broccoli head is susceptible to broccoli brown head (associated with warm temperature), head rot (favored by cool temperatures and prolonged periods of moisture), and other physiological disorders. Susceptibility of broccoli heads to these issues vary based on cultivars and varieties. Identifying appropriate cultivars better suited for Midwest growing conditions also is crucial to enhance broccoli production in Iowa. In addition to evaluating row cover materials, this study evaluated six popular broccoli cultivars for their performance in Iowa growing conditions.

Materials and Methods

Six broccoli cultivars—Asteroid, Emerald Star, Green Gold, Green Magic, Gypsy, and Luna—were seeded in 50-celled flats March 10, 2018, at the Department of Horticulture greenhouses. Broccoli was moved out of the greenhouse April 21, 2018, and placed under a lath-house for acclimation. Plots at the Horticulture Research Station were tilled April 25, 2018, and white-on-black plastic mulch was laid on raised beds. Before tilling, 100, 50, and 50 lb/acre of N, P₂O₅, and K₂O was applied. On April 26, 2018, broccoli was transplanted. Beds were spaced 5.5 ft apart and broccoli was transplanted in double rows 15 inches apart. In-row spacing was 12 inches. Experimental design was a split plot randomized complete block design with row cover material as the whole plot and cultivar as the sub-plot factor. Row cover treatment consisted of Protek net, Agribon-19, and a no-

cover treatment. Protek net was installed on hoops made from 10 ft long, 1-inch electrical conduits. Row covers were installed on 9-gauge, galvanized iron hoops. Each sub-plot treatment (cultivar) consisted of a bed 12 ft long with two rows of broccoli transplanted as mentioned above. Temperature and light sensors were installed within each treatment.

Agribon row covers were removed the last week of May. No-cover plots and Agribon-19 plots were sprayed twice in June with Bt (*Bacillus thuringiensis*) insecticide to manage cabbage loopers. Protek net was not removed until the harvest. Plots were harvested four times between June 18 and June 26, 2018. Data was collected on marketable heads, several categories of non-marketable heads, and head diameter.

Results and Discussion

Broccoli marketable yield. There were no significant differences in broccoli yield between row cover treatments (Table 1). Cultivars had a strong effect on yield with Green Gold and Emerald Star producing higher marketable yields than Green Magic, Gypsy, and Luna.

Non-marketable heads. Non-marketable heads were classified into four categories: loose heads, heads with beaded appearance, brown discoloration, and small sized (Figure 1). Gypsy produced the highest number of loose heads (Table 1). Heads with beaded appearance, rendering them non-marketable, were highest in Luna, followed by Green Magic. Heads with brown discoloration were highest in Green Magic. Heads categorized non-marketable due to small size were highest in Asteroid.

Average head diameter. Row cover treatments did not impact average head diameter. Differences existed between cultivars with head diameters ranging from 4.1 to 5.7 inches

(Table 2). Green Magic had the lowest head diameter when compared with Asteroid, Emerald Star, Green Gold, and Luna.

Hollow stem. Row cover treatment was significant for hollow stem (Figure 1). No-cover treatment had heads with lower hollow stems than Agribon-19 treatment (Table 2). Between cultivars, Gypsy and Asteroid had the highest number of heads with hollow stems. Emerald Star had the least number of heads with hollow stem. Factors that contribute to hollow stem include boron (B) deficiency, high temperature, wide spacing, and cultivars. Average soil concentration of boron is between 9 to 85 ppm, however, in vegetable production B is enough if soil test indicates 0.7 ppm. In this study, soil B concentration was 0.4 ppm, which contributed to the presence of hollow stem.

Temperature and light. There were differences in air temperature between row cover treatments (Table 3). In the month of May, average air temperature was highest under Agribon-19 (78.6°F) followed by Protek net (75.5°F) and no-cover treatment (74.4°F). The maximum air temperature of 120.3°F was recorded under the row cover. Air temperature has significant impact on head formation, maturity, and quality in broccoli. Higher air temperatures have detrimental effects on broccoli head quality as they cause defects such as brown discoloration, fuzziness, and loose heads, which render the heads non-marketable. For light intensity, Protek net and Agribon-19 reduced light intensity by 11.7 and 27.9 percent, respectively, when compared with no-cover treatment.

This study showed Protek net and Agribon-19 could be successfully utilized to mitigate insect pest damage in broccoli production. With Protek net, there is an added advantage of zero insecticide applications as the netting can remain on the crop until harvest. Cultivars

play a critical role in broccoli production. Growers should use appropriate cultivars better adapted to their growing region. Emerald Star and Green Gold produced a higher number of marketable heads and relative lower proportion of non-marketable heads. Soil boron concentration also is very crucial for broccoli production as it has direct implications on head quality.

Acknowledgements

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Table 1. Broccoli yield at the Horticulture Research Station, Ames, IA, from 2018 growing season.*

Treatment	Marketable		Non-marketable (size)		Loose headed		Beaded appearance		Brown discoloration	
	No.	Weight (kg)	No.	Weight (kg)	No.	Weight (kg)	No.	Weight (kg)	No.	Weight (kg)
Cover										
No-cover	8.3	2.53	3.6	0.42	1.9	0.60	3.2	0.78	1.5	0.41
Protek net	10.0	3.35	3.4	0.36	1.9	0.50	2.9	0.98	2.1	0.71
Agribon-19	8.3	2.45	2.9	0.48	2.6	0.74	2.5	0.67	2.5	0.81
<i>Significance</i>	<i>0.1123</i>	<i>0.3385</i>	<i>0.7160</i>	<i>0.5237</i>	<i>0.6224</i>	<i>0.5228</i>	<i>0.6024</i>	<i>0.4219</i>	<i>0.1806</i>	<i>0.1408</i>
Cultivar										
Asteroid	11.4 b*	3.34 b	4.8 a	0.58 ab	2.75 ab	0.80 ab	0.16 c	0.02 c	0.58 b	0.12 b
Emerald Star	13.9 ab	3.80 b	1.1 b	0.15 c	1.08 b	0.30 b	0.33 c	0.07 c	1.16 b	0.36 b
Green Gold	14.1 a	5.67 a	2.3 b	0.34 bc	2.20 b	0.64 b	0.58 c	0.20 c	0.20 b	0.09 b
Green Magic	1.6 d	0.42 d	2.9 ab	0.31 bc	1.25 b	0.31 b	4.50 b	1.21 b	9.66 a	3.02 a
Gypsy	8.1 c	2.38 bc	5.6 a	0.68 a	4.69 a	1.38 a	0.33 c	0.10 c	0.13 b	0.04 b
Luna	4.1 d	1.07 cd	3.1 ab	0.46 abc	0.91 b	0.26 b	11.1 a	3.25 a	0.58 b	0.22 b
<i>Significance</i>	<i><.0001</i>	<i><.0001</i>	<i>0.0138</i>	<i>0.0270</i>	<i>0.0048</i>	<i>0.0087</i>	<i><.0001</i>	<i><.0001</i>	<i><.0001</i>	<i><.0001</i>

*Data collected from twin-rows, 12 ft long and have a total of 20 plants.

**Mean separation within columns and treatments using Fisher's protected t-test; means followed by same letter(s) are not significantly different ($P \leq 0.05$).

Table 2. Broccoli average head diameter and number of heads with hollow stem.

Treatment	Average head diameter (cm)*	Hollow stem numbers**
Cover		
No-cover	5.1	3.4 b
Protek net	5.2	7.3 ab
Agribon-19	4.9	9.1 a
<i>Significance</i>	<i>0.3303</i>	<i>0.0217</i>
Cultivar		
Asteroid	5.7 a***	8.6 ab
Emerald Star	5.2 a	3.3 c
Green Gold	5.3 a	3.4 c
Green Magic	4.1 b	7.0 b
Gypsy	4.8 ab	11.9 a
Luna	5.1 a	5.3 bc
<i>Significance</i>	<i>0.0448</i>	<i>0.0002</i>

*Average head diameter collected from each treatment by randomly sampling 10 plants.

**Hollow stem data collected from twin-rows, 12 ft long and have a total of 20 plants.

***Mean separation within columns and treatments using Fisher's protected t-test; means followed by same letter(s) are not significantly different ($P \leq 0.05$).

Table 3. Average, minimum, and maximum air temperatures May 2018 at the ISU Horticulture Research Station, Ames, IA.

Cover	Air temperature (°F)		
	May		
	Average	Minimum	Maximum
No-cover	74.4	54.3	102.7
Protek net	75.5	54.5	108.1
Agribon-19	78.6	53.6	120.3

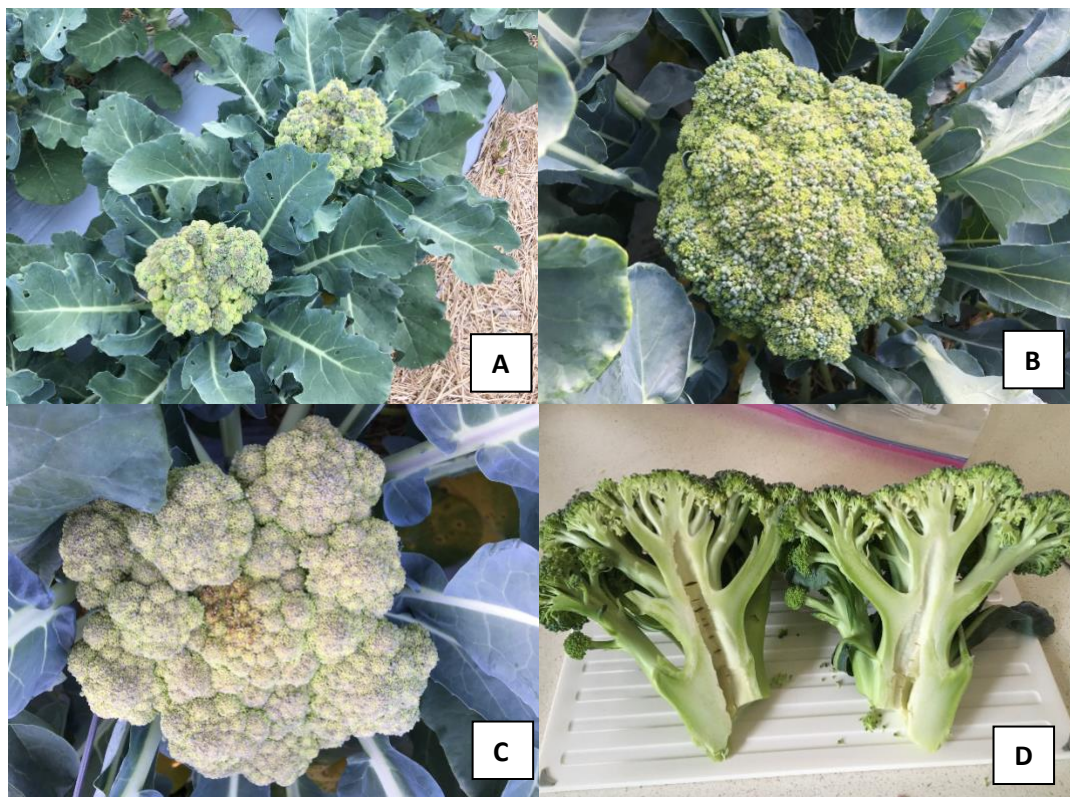


Figure 1. Non-marketable broccoli heads: loose heads (A), beaded heads (B), brown discoloration, and hollow stems (D).