

Improving management of white mold in soybeans and dry beans:

Impact of fungicide application rate and application frequency; response to fungicides relative to the growth stage at which conditions favor white mold.

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Sclerotinia management in soybeans Efficacy of Cobra herbicide (lactofen)

Cobra herbicide 6.0 fl oz/ac: single application at late R1 to early R2

Active ingredient: lactofen 43 g ai/ac



Fungicide application methods: 15 to 17.5 gal/ac, 35 or 40 psi, flat-fan nozzles with fine or medium droplets **Fungicide performance across 15 field trials** conducted at one location (Carrington, ND) across three years

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Endura 5.5 OZ/AC: single application at late R1 to early/mid R2 Active ingredient: **boscalid** 109 g ai/ac



Fungicide application methods: 15 to 17.5 gal/ac, 35 or 40 psi, flat-fan nozzles with fine or medium droplets Fungicide performance across 45 field trials conducted at three locations (Carrington, Langdon and Oakes, ND) across six years

Endura 8.0 OZ/AC: single application at late R1 to early/mid R2 Active ingredient: **boscalid** 159 g ai/ac



Fungicide application methods: 15 to 17.5 gal/ac, 35 or 40 psi, flat-fan nozzles with fine or medium droplets **Fungicide performance across 33 field trials** conducted at four locations (Carrington, Hofflund, Langdon and Oakes, ND) across six years

Endura 8.0 OZ/AC: two applications, late R1 to early/mid R2 + 10-14 days later Active ingredient: **boscalid** 159 g ai/ac



Fungicide application methods: 15 to 17.5 gal/ac, 35 or 40 psi, flat-fan nozzles with fine or medium droplets **Fungicide performance across 11 field trials** conducted at one location (Carrington, ND) across four years

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Fungicide performance in one replicated field trial:

Fungicide application methods: 15 to 17.5 gal/ac, 35 or 40 psi, flat-fan nozzles with fine or medium droplets **Fungicide performance across 45 field trials** conducted at three locations (Carrington, Langdon and Oakes, ND) across six years

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ASSESSING RISK OF SCLEROTINIA Rainfall frequency

Carrington, ND (2014) - SOYBEANS:

Using overhead irrigation as a proxy for rainfall: What is the impact of irrigation frequency on Sclerotinia disease development?

Vegetative growth and early bloom: All treatments -

- Rainfall or irrigation every 1 to 4 days
- Favorable for apothecia production

Full bloom & early to mid pod:

- 1.35 in. every 9 days
- 0.90 in. every 6 days
- 0.45 in. every 3 days



ASSESSING RISK OF SCLEROTINIA

Rainfall frequency

Frequent, light irrigation: strong return to two fungicide applications



ASSESSING RISK OF SCLEROTINIA Rainfall frequency



ASSESSING RISK OF SCLEROTINIA Rainfall frequency

Infrequent, heavy irrigation: single fungicide application sufficient



Sclerotinia management in soybeans Impact of soybean maturity on white mold

Carrington, ND (2014)

			White Mold Incidence		Soybean Yield 13% moisture
Company	Variety	Maturity	Percent of plants		bushels/acre
Pioneer	90Y21 (R)	0.2	12	а	42
Pioneer	90Y20 (S)	0.2	31	с	35
ProSeed	10-20 (R)	0.2	19	b	36
ProSeed	20-30 (S)	0.3	46	cde	31
Kruger	K2-0402 (S)	0.4	45	cde	33
Kruger	K2-0504 (R)	0.5	56	е	29
Pioneer	90Y51 (R)	0.5	56	е	29
Pioneer	90Y50 (S)	0.5	36	с	34
Mycogen	5B065R2 (S)	0.6	63	е	31
Mycogen	5B080R2 (R)	0.8	50	de	31
Kruger	K2-0801 (S)	0.8	57	е	28
Pioneer	90M80 (S)	0.8	45	cde	27
Kruger	K2-0901 (R)	0.9	62	е	26
Pioneer	90Y90 (R)	0.9	34	cd	33
			CV: 12.5		CV: 14.3

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а а bcd

Sclerotinia management in soybeans Differences in susceptibility to white mold across soybean varieties

White mold severity index and soybean yield averaged across fungicide-treated and non-treated soybeans.

Carrington, ND				White mold	(%)		Yield (bu/ac)	
2018	Soybean			average across all fungicide treatments			average across all fungicide treatments	
	rating	Company	Variety	Percent of canopy;	R8 growth	stage	13% moisture	
	0.06 0.05 0.05 0.08 0.09 0.4 0.1 0.3 0.2 0.08	Pioneer Pioneer Dairyland Pioneer Dairyland Pioneer Peterson Farms Pioneer Dairyland	P006A37X P005A27X DSR-C506/R2Y P008T22R2 DSR-C905/R2Y P04A77X 16R01 P03T68R2 DSR-0225/R2Y 19Y008N	1 1 2 2 3 5 6 7 8		a abc abc a-d a-e a-f a-g c-i	59 55 57 59 54 61 61 58 60	ab abc abc abc abc abc ab ab ab
	0.08 0.08 0.7	Peterson Farms Peterson Farms Dairyland	16R008N DSR-0711/R2Y	8 9 9		c-j c-j	60 57 62	a abc
Completely randomized	0.8 0.09	Pioneer Dairyland	P08A72X DSR-C918/R2Y	15 17		d-k e-k	55 49	abc abc
split-plot design	0.8 1.0 0.6	Peterson Farms Pioneer Pioneer	18X08N P10A76X P06A45X	<u>17</u> <u>18</u> 18		e-l e-l f-l	59 51 55	abc abc
Main factor =	0.09 0.2	Peterson Farms Pioneer	17X009 P02A33X	19 20		f-l e-l	46 50	abc
Variety	1.0 0.6 0.8	Pioneer Pioneer Dairvland	P10T91R P06T28R DSR-0807/R2Y	20 21 21		f-l f-l f_l	50 52 56	abc abc
Sub-factor =	0.4 0.4	Dairyland Peterson Farms	DSR-0404/R2Y 17X04N	<u>21</u> 21 21		f-l f-l	49 49	abc abc abc
1. No foliar fungicide	0.2	ProSeed Peterson Farms	30-20 18X07N	21 23		f-l g-l	47	abc abc
2. Endura 5.5 oz applied once at late R1 to early R2	0.4 0.3 0.7 0.4	Peterson Farms Peterson Farms ProSeed	13R03 15R07N XT60-40RR2Y	23 25 25 25		g-I g-I h-I b-I	45 45 50	abc abc abc
3. Endura 5.5 oz applied twice	0.6 0.09 0.9	Peterson Farms Peterson Farms Dairyland	18X06N 17R009 DSR-0988/R2Y	27 27 27 28		i-l i-l i-l	43 44 46	a-d abc
K 1/KZ + 10-12 days	0.3	Dairyland Pioneer	DSR-0305/R2Y P05A93X	29 31		jkl jkl	46 38	abc cd
XR110015 flat-fan nozzles	0.9 0.9	Peterson Farms Peterson Farms	14R09N 17X09N	32 37 53		jĸi kl	43 39 24	a-d bcd d
spray volume = 15 gal/ac	Within		followed by d	CV = 11.2		Latters are s	CV = 9.8	v procedure)

Within-column means followed by different, non-overlapping ranges of letters are significantly different (P < 0.05; Tukey procedure)

Sclerotinia management in soybeans Relationship between soybean maturity and white mold susceptibility

White mold severity index and soybean yield averaged across fungicide-treated and non-treated soybeans.

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Carrington, ND Yield (bu/ac) White mold (%) 2018 average across all fungicide treatments average across all fungicide treatments Soybean maturity Percent of canopy; R8 growth stage 13% moisture rating Company Variety 0.05 DSR-C506/R2Y Dairyland 2 abc 57 0.05 P005A27X 1 55 Pioneer ab 0.06 P006A37X 59 Pioneer 1 а 0.08 Peterson Farms 16R008N 57 c-j 0.08 18X008N Peterson Farms b-h 60 8 0.08 P008T22R2 59 Pioneer 2 abc 0.09 27 Peterson Farms 17R009 i-l 44 0.09 17X009 Peterson Farms 19 f-l 46 0.09 DSR-C918/R2Y Dairyland 17 e-k 49 0.09 DSR-C905/R2Y 54 Dairyland 3 a-d 0.1 Peterson Farms 16R01 a-f 61 0.2 30-20 47 ProSeed f-l 21 Completely 0.2 0.2 Pioneer P02A33X e-l 50 20 DSR-0225/R2Y randomized Dairyland c-i 8 60 0.3 13R03 45 Peterson Farms g-l 25 split-plot design 0.3 P03T68R2 Pioneer a-g 58 0.3 ikl DSR-0305/R2Y 46 Dairyland 29 DSR-0404/R2Y 0.4 Dairvland 21 f-l 49 Main factor = 0.4DSR-0418/R2Y Dairyland 23 45 g-l 0.4 Peterson Farms 17X04N 21 f-l 49 Variety 0.4 P04A77X Pioneer 5 а-е 61 0.4ProSeed XT60-40RR2Y 25 h-l 46 0. 5 P05A93X 31 38 Sub-factor = ikl Pioneer 0.6 P06T28R 21 f-l Pioneer 52 Fungicide treatment 0.6 P06A45X Pioneer 18 f-l 55 1. No foliar fungicide 0.6 18X06N 27 i-l Peterson Farms 43 0.7 Peterson Farms 15R07N 25 h-l 50 2. Endura 5.5 oz 0.7 18X07N 23 44 Peterson Farms g-l applied once DSR-0711/R2Y 0.7 Dairvland 9 c-j 62 at late R1 to early R2 0.8 18X08N Peterson Farms 59 17 e-l 0.8 55 3. Endura 5.5 oz Pioneer P08A72X 15 d-k 0.8 DSR-0807/R2Y Dairyland 21 f-l 56 applied twice 0.9 Peterson Farms 14R09N kl 37 39 R1/R2 + 10-12 days 0.953 24 Peterson Farms 17X09N 0.9 DSR-0904/R2Y 32 jkl 43 Dairyland 0.9 Fungicides applied with Dairvland DSR-0988/R2Y 28 i-l 46 1.0 P10T91R Pioneer 20 f-l 50 XR110015 flat-fan nozzles 1.0 Pioneer P10A76X 18 e-l 51 at 40 psi (fine droplets); CV = 11.2CV = 9.8

Within-column means followed by different, non-overlapping ranges of letters are significantly different (P < 0.05; Tukey procedure)

spray volume = 15 gal/ac

Sclerotinia management in soybeans Differences in susceptibility to white mold across soybean varieties

White mold severity index and soybean yield averaged across fungicide-treated and non-treated soybeans.

Oakes, ND				White mold (%)		Yield (bu/ac)	
2018	Soybean maturity rating Company Variety		average across all fu	ngicide treatments	average across all fungicide treatments		
			Variety	Percent of canopy;	R8 growth stage	13% moisture	
	0.2	Dairyland	DSR-0225/R2Y	1	а	61	bc
	0.3	Dairyland	DSR-0305/R2Y	2	ab	73	ab
	0.1	Pioneer	P01T06R	2	abc	72	abc
	0.4	Dairyland	DSR-0418/R2Y	3	a-e	68	abc
	0.1	Peterson	16R01	3	a-d	59	с
	0.4	Peterson	17X04N	4	a-f	72	abc
	0.4	Dairyland	DSR-0404/R2Y	5	a-g	69	abc
Completely	0.4	Pioneer	P04A77X	5	a-g	65	abc
completely	0.7	Dairyland	DSR-0711/R2Y	5	b-g	74	ab
	0.3	Peterson	13R03	5	b-h	73	ab
spin-plot design	1.2	Dairyland	DSR-1120	6	b-h	71	abc
Main factor	0.8	Peterson	18X08N	6	b-h	73	ab
Main factor =	0.7	Peterson	18X07N	6	b-g	71	abc
variety	0.8	Dairyland	DSR-0807/R2Y	6	b-h	70	abc
Cub factor	0.4	ProSeed	XT60-40RR2Y	6	b-h	70	abc
Sub-factor =	1.3	Peterson	17X13	7	b-h	76	a
Fungicide treatment	0.2	ProSeed	30-20	7	c-i	66	abc
2 Endura 5.5 oz	1.1	Pioneer	P11T22R2	9	d-i	67	abc
applied once	0.6	Peterson	18X06N	9	e-i	65	abc
at late R1 to full R2	0.9	Dairyland	DSR-0988/R2Y	9	e-i	72	abc
3. Endura 5.5 oz	0.9	Dairyland	DSR-0904/R2Y	11	f-i	68	abc
applied twice	1.1	Peterson	14R11N	13	ghi	65	abc
R1/R2 + 10-12 days	0.9	Peterson	17X09N	14	ghi	68	abc
Fungicides applied with	1.1	Peterson	18X11N	17	hi	62	bc
XR110015 flat-fan nozzles	1.1	Pioneer	P11A95X	22	i	59	с
at 40 psi (fine droplets);				CV: 19.4		CV: 6.0	
spray volume = 15 gal/ac	Withi	in-column me	ans followed by dif	ferent, non-overlapping r	anges of letters are sig	chificantly different (P < 0.05; Tukey pro	cedure)

Within-column means followed by different, non-overlapping ranges of letters are significantly different (P < 0.05; Tukey procedure)

Sclerotinia management in soybeans Relationship between soybean maturity and white mold susceptibility

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1.1

1.1

1.1

1.2

1.3

Variety, maturity rating

P01T06R

DSR-0225/R2Y

DSR-0305/R2Y

DSR-0418/R2Y

XT60-40RR2Y

DSR-0404/R2Y

DSR-0711/R2Y

DSR-0807/R2Y

DSR-0988/R2Y

DSR-0904/R2Y

16R01

30-20

13R03

P04A77X

17X04N

18X06N

18X07N

18X08N

17X09N

14R11N

18X11N

P11A95X

DSR-1120

17X13

P11T22R2

Company

Pioneer

Peterson

ProSeed

Dairyland

Peterson

Dairyland

Dairyland

Peterson

ProSeed

Dairyland

Peterson

Dairyland

Peterson

Peterson

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Dairyland

Peterson

Pioneer

White mold severity index and soybean yield averaged across fungicide-treated and non-treated soybeans.

Oakes, ND 2018

White mold (%)

Yield (bu/ac)

average across all fungicide treatments

average across all fungicide treatments

Percent of canopy; R8 growth stage

13% moisture



Completely randomized split-plot design

Main factor = Variety

Sub-factor = Fungicide treatment

- 1. No foliar fungicide
- 2. Endura 5.5 oz applied once at late R1 to full R2
- 3. Endura 5.5 oz applied twice R1/R2 + 10-12 days

Fundicides applied with XR110015 flat-fan nozzles at 40 psi (fine droplets); spray volume = 15 gal/ac

Within-column means followed by different, non-overlapping ranges of letters are significantly different (P < 0.05; Tukey procedure)

White mold (% of canopy)

Carrington, ND (2018)

Soybean maturity rating

Assigned by the breeder



White mold reduction (%) Single fungicide application late R1 / early R2 growth stage



White mold reduction (%) Two fungicide applications late R1 / early R2 + 10-12 days later



* Asterisk: denotes a significant (P < 0.05) disease reduction relative to the no-fungicide treatment

Soybean Yield (bu/ac)

No fungicide applied

Carrington, ND (2018)

Soybean maturity rating

Assigned by the breeder

			13% moisture
	Company	Variety	
0.05	Dairyland	DSR-C506/R2Y	57
0.05	Pioneer	P005A27X	53
0.06	Pioneer	P006A37X	61
0.08	Peterson Farms	16R008N	55
0.08	Peterson Farms	18X008N	60
0.08	Pioneer	P008T22R2	60
0.09	Peterson Farms	17R009	38
0.09	Peterson Farms	17X009	39
0.09	Dairyland	DSR-C918/R2Y	47
0.09	Dairyland	DSR-C905/R2Y	51
0.1	Peterson Farms	16R01	61
0.2	ProSeed	30-20	46
0.2	Pioneer	P02A33X	43
0.2	Dairyland	DSR-0225/R2Y	64
0.3	Peterson Farms	13R03	37
0.3	Pioneer	P03T68R2	58
0.3	Dairyland	DSR-0305/R2Y	44
0.4	Dairyland	DSR-0404/R2Y	44
0.4	Dairyland	DSR-0418/R2Y	38
0.4	Peterson Farms	17X04N	45
0.4	Pioneer	P04A77X	61
0.4	ProSeed	XT60-40RR2Y	41
0.5	Pioneer	P05A93X	28
0.6	Pioneer	P06T28R	46
0.6	Pioneer	P06A45X	45
0.6	Peterson Farms	18X06N	38
0.7	Peterson Farms	15R07N	49
0.7	Peterson Farms	18X07N	37
0.7	Dairyland	DSR-0711/R2Y	54
0.8	Peterson Farms	18X08N	50
0.8	Pioneer	P08A72X	46
0.8	Dairyland	DSR-0807/R2Y	51
0.9	Peterson Farms	14R09N	37
0.9	Peterson Farms	17X09N	17
0.9	Dairyland	DSR-0904/R2Y	37
0.9	Dairyland	DSR-0988/R2Y	40 $y = 54.718 - 0.4128x$
1.0	Pioneer	P10T91R	48
1.0	Pioneer	P10A76X	46

Yield Gain (bu/ac) Single fungicide application late R1 / early R2 growth stage



Yield Gain (bu/ac) Two fungicide applications late R1 / early R2 + 10-12 days later



* Asterisk: denotes a significant (P < 0.05) yield increase relative to the no-fungicide treatment

Oakes, ND (2018)

Soybean maturity rating

Assigned by the breeder

			R8 growth st
0.4	Company	Variety	
0.1	Pioneer	P01106R	3
0.1	Peterson	16R01	4
0.2	ProSeed	30-20	9
0.2	Dairyland	DSR-0225/R2Y	2
0.3	Peterson	13R03	9
0.3	Dairyland	DSR-0305/R2Y	3
0.4	Pioneer	P04A77X	6
0.4	Dairyland	DSR-0418/R2Y	3
0.4	Peterson	17X04N	5
0.4	ProSeed	XT60-40RR2Y	8
0.4	Dairyland	DSR-0404/R2Y	7
0.6	Peterson	18X06N	11
0.7	Dairyland	DSR-0711/R2Y	9
0.7	Peterson	18X07N	9
0.8	Peterson	18X08N	8
0.8	Dairyland	DSR-0807/R2Y	8
0.9	Dairyland	DSR-0988/R2Y	12
0.9	Dairyland	DSR-0904/R2Y	13
0.9	Peterson	17X09N	18
1.1	Pioneer	P11T22R2	13
1.1	Peterson	14R11N	17
1.1	Peterson	18X11N	21
1.1	Pioneer	P11A95X	29
1.2	Dairyland	DSR-1120	8
1.3	Peterson	17X13	9

White mold (% of canopy) No fungicide applied

R8 growth stage



White mold reduction (%) Single fungicide application late R1 / early R2 growth stage



White mold reduction (%) Two fungicide applications late R1 / early R2 + 10-12 days later



* Asterisk: denotes a significant (P < 0.05) disease reduction relative to the no-fungicide treatment

Oakes, ND (2018)

Soybean maturity rating			Yield (bu/ac)	d Yield Gain (bu/ac)			Yield Gain (bu/ac)		
Assigned by the breeder			No fungicide applied	d Single fungicide application			Two fungicide applications		
$\begin{array}{c} 0.1\\ 0.2\\ 0.2\\ 0.3\\ 0.4\\ 0.4\\ 0.4\\ 0.4\\ 0.6\\ 0.7\\ 0.8\\ 0.9\\ 0.9\\ 1.1\\ 1.1\\ 1.2\\ 1.3\\ \end{array}$	Company Pioneer Peterson ProSeed Dairyland Peterson Dairyland Peterson Dairyland Peterson Dairyland Peterson Dairyland Dairyland Dairyland Dairyland Dairyland Dairyland Peterson Pioneer Peterson Pioneer Peterson	Variety P01T06R 16R01 30-20 DSR-0225/R2Y 13R03 DSR-0305/R2Y P04A77X DSR-0418/R2Y 17X04N XT60-40RR2Y DSR-0404/R2Y 18X06N DSR-0404/R2Y 18X07N 18X08N DSR-0711/R2Y 18X07N 18X08N DSR-0904/R2Y DSR-0904/R2Y 17X09N P11T22R2 14R11N 18X11N P11A95X DSR-1120 17X13	68 54 64 58 69 70 60 67 71 68 67 63 75 66 69 70 63 75 66 69 70 64 62 61 62 52 69 75	y = 64.982 + 0.0314x R ² = 0.0017	5 5 3 5 7 3 6 2 -1 0 3 6 2 -1 0 3 6 7 1 5 6 6 2 -2 3 7 1 5 6 2 -3 4 3 3 3	y = 3.9515 - 0.0601x R ² = 0.0292	7 9 * 3 4 5 4 * 9 * 2 4 4 * 3 5 0 10 * 7 4 4 9 12 8 10 * 4 17 * 4 1	y = 4.5593 + 0.1055x R ² = 0.0410	

* Asterisk: denotes a significant (P < 0.05) yield increase relative to the no-fungicide treatment

Sclerotinia management in soybeans Impact of Sclerotinia infection timing on disease levels and yield

CARRINGTON (2015)

Disease and yield - no fungicide:

Dairyland 'DSR0305 / R2Y' 0.3 maturity



Irrigated Aug. 8 - Aug. 31 (R4-R6)

Growth stages in which
soybeans received intensive
irrigation favoring white moldWhite Mold
Incidence
Percent of plantsSoybean
Yield
bu/ac (13% moisture)R2 to R44842R4 to R61859

Response to a single fungicide application:

Endura 5.5 oz/ac applied at 100% R2

Growth stages in which soybeans received intensive irrigation favoring white mold

Decrease in White Mold

Percent of plants

Increase in Yield

bu/ac (13% moisture)



R4 to R6 6

Fungicide application methods: XR8001 flat-fan nozzles, 35 psi (fine droplets); 15 gal/ac

Sclerotinia management in soybeans Response to fungicide applications relative to Sclerotinia infection timing

CARRINGTON (2014)

Disease and yield - no fungicide:

Dairyland 'DSR0404 / R2Y' 0.4 maturity



Irrigated Aug. 3 - 30 (R2-R6)

Growth stages in which
soybeans received intensive
irrigation favoring white moldWhite Mold
Incidence
Percent of plantsSoybean
Yield
bu/ac (13% moisture)R1 to R65637R2 to R64143

Response to a single fungicide application:

Endura 5.5 oz/ac applied at 100% R2

R1 to R6 21

R2 to R6 19

Growth stages in which soybeans received intensive irrigation favoring white mold

Decrease in White Mold

Percent of plants

Increase in Yield

bu/ac (13% moisture)



Fungicide application methods: XR8001 flat-fan nozzles, 35 psi (fine droplets); 15 gal/ac

SCLEROTINIA INFECTION TIMING: DRY EDIBLE (PINTO) BEANS

2014: Disease progression relative to intensive irrigation



Irrigated Aug. 3 - 30 (R3 - R6 growth stage)

SCLEROTINIA INFECTION TIMING: DRY EDIBLE (PINTO) BEANS

2014: Apothecia production relative to intensive irrigation

INTENSIVE IRRIGATION	APOTHECIA / m ²			
14-inch rows	July 30 (R2)	Aug. 19 (R5)		
July 8 - Aug. 30 (V4-R6)	0.2	2.3		
July 23 - Aug. 30 (R2-R6)	0.1	1.6		
Aug. 3-30 (R3-R6)	0.06	0.7		

28-inch rows	July 30 (R2)	Aug. 19 (R5)
July 8 - Aug. 30 (V4-R6)	0	1.5
July 23 - Aug. 30 (R2-R6)	0.05	1.9
Aug. 3-30 (R3-R6)	0	0.3

2014: Response to fungicides





Thank You!

Research funding:

North Dakota Soybean Council USDA National Sclerotinia Initiative Northarvest Bean Growers Association North Dakota Crop Protection Product Registration and Harmonization Board



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