



EVALUATION OF STROBILURIN ON BIOPHYSICAL, BIOCHEMICAL PARAMETERS IN SOYBEAN [*GLYCINE MAX* (L.) MERRILL]

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Introduction

Soybean [*Glycine max* (L) Merrill.] belonging to family Papilionaceae, possess a very high nutritional value. It contains about 20 per cent oil and 40 per cent high quality protein. To overcome the problem of stresses, there are many avenues *viz.*, development of resistant genotypes, seed hardening techniques, use of anti transpirants, alcohol and certain class of fungicides. Mitigating plant stress, whether from fungal pathogens or environment factors, is critical to maximizing crop yield performance. Today, fungal pathogens can be effectively controlled by broad-spectrum fungicides such as the strobilurin group. F-500 (pyraclostrobin) strobilurin, a new generation broad spectrum fungicide has been shown to cause long term changes in the metabolism and growth of treated plants resulting in higher biomass and yield (Koehle *et al.*, 2003; Glaab and Kaiser, 1999), apart from inducing drought tolerance in the treated plants. Considering the ever increasing demand for food production with the limited availability of water supply and shrinking cultivable area day by day, it is necessary to go for agro-chemicals, which enhance the growth and development vis-à-vis productivity. The present study would highlight the role of strobilurin in inducing disease resistance as well as drought tolerance in soybean, which is susceptible to both biotic and abiotic stresses. The study would also highlight the mechanism by which it alters the plant metabolism leading to higher productivity in soybean.

Methods

A field experiment was conducted to study the effect of strobilurin on biophysical and biochemical parameters in soybean using factorial randomized block design with three replications. The experiment consisted of four

genotypes (JS-335, KHSb-2, DSb-1 and DSb-11) and three foliar applications of strobilurin (150 g/ac, 175 g/ac and 200 g/ac) and a control. In all there were 16 treatment combinations. The biophysical parameters like photosynthetic rate and biochemical parameters like chlorophyll content, nitrate reductase activity, super oxy dismutase, ascorbic acid content and phenol content were studied.

Results and Discussion

Photosynthesis was maximum at 21 DAS and further it was reduced from 28 to 35 DAS in all the treatments and varieties and the extent of increase was more from 14 to 21 DAS. Among the varieties, it was maximum in KHSb-2 followed by DSb-11 and lowest photosynthesis was observed in DSb-1 in all the stages.

Similarly, Grossmann and Retzlaff (1997) reported that, the strobilurin Kresoxim-methyl proved to inhibit the biosynthesis of ethylene through reduction of the activity of 1-aminocyclopropane-1-carboxylic acid (ACC)-synthase in tissue of wheat buds. This was related to the delay in the senescence of leaves and, as a result, to the prolonged photosynthetic activity of green tissue and a better management of stress (Köehle *et al.*, 1997). The chlorophyll content decreased with the age of the crop. It differed significantly with treatments and genotypes at all the stages. It increased upto 21 DAS and declined thereafter in all the genotypes and treatments. KHSb-2 recorded maximum chlorophyll content and lowest was recorded in DSb-1 in all the stages.

Superoxide dismutase (SOD) activity in leaves is the primary scavenger of superoxide radicals and helps in decreasing ageing of leaf tissues, which is consistent with the increase of reactive oxygen intermediates (ROI) production during plant senescence. Treatment with

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Table 1 . Effect of strobilurin (pyraclostrobin 20% WG) on photosynthesis ($\mu\text{mol m}^2\text{s}^{-1}$) in soybean genotypes.

Treatments	Days after spray														
	0					7					14				
	V ₁	V ₂	V ₃	V ₄	Mean	V ₁	V ₂	V ₃	V ₄	Mean	V ₁	V ₂	V ₃	V ₄	Mean
T ₁ - Control	10.53	11.10	10.40	10.60	10.66	12.03	11.50	12.10	12.40	12.01	15.50	17.10	15.00	15.80	15.85
T ₂ - 150 g/ac	10.60	11.20	10.50	10.37	10.67	12.80	12.20	12.70	13.03	12.68	16.20	17.83	15.83	16.33	16.55
T ₃ - 175 g/ac	10.60	11.20	10.60	10.70	10.78	13.30	12.50	12.90	12.93	12.91	16.63	18.33	16.33	16.83	17.03
T ₄ - 200 g/ac	10.60	11.30	10.60	10.80	10.83	14.60	14.03	14.30	14.80	14.43	18.03	19.53	17.63	18.13	18.33
Mean	10.58	11.20	10.53	10.62	10.73	13.18	12.56	13.00	13.29	13.01	16.59	18.20	16.20	16.77	16.94
For comparing means of	SEM±		CD at 5%			SEM±		CD at 5%			SEM±		CD at 5%		
Varieties (V)	0.200		NS			0.204		NS			0.280		0.809		
Treatments (T)	0.200		NS			0.204		0.588			0.280		0.809		
Interaction (V×T)	0.401		NS			0.408		NS			0.560		NS		

V₁: JS-335 V₂: KHSb-2 V₃: DSb-1 V₄: DSb-11 NS: Non-significant

Table 1 continued.

Treatments	Days after spray														
	21					28					35				
	V ₁	V ₂	V ₃	V ₄	Mean	V ₁	V ₂	V ₃	V ₄	Mean	V ₁	V ₂	V ₃	V ₄	Mean
T ₁ - Control	20.10	20.30	18.00	20.20	19.65	16.50	17.80	16.20	16.70	16.8	13.53	14.63	13.43	13.70	13.82
T ₂ - 150 g/ac	20.90	21.03	18.73	21.03	20.42	17.13	18.53	17.03	17.23	17.5	14.13	15.33	14.03	14.33	14.46
T ₃ - 175 g/ac	21.20	21.53	18.83	21.43	20.75	17.73	19.13	17.33	18.10	18.1	14.53	16.03	14.33	15.23	15.03
T ₄ - 200 g/ac	22.50	22.80	20.73	22.70	22.18	19.03	20.90	18.83	19.33	19.5	16.20	17.43	15.73	16.53	16.47
Mean	21.18	21.42	19.07	21.34	20.75	17.60	19.09	17.35	17.84	18.3	14.60	15.86	14.38	14.95	14.95
For comparing means of	SEM±		CD at 5%			SEM±		CD at 5%			SEM±		CD at 5%		
Varieties (V)	0.344		0.994			0.310		0.897			0.268		0.775		
Treatments (T)	0.344		0.994			0.310		0.897			0.268		0.775		
Interaction (V×T)	0.689		NS			0.621		NS			0.537		NS		

V₁: JS-335 V₂: KHSb-2 V₃: DSb-1 V₄: DSb-11 NS: Non-significant

Table 2 : Effect of strobilurin (pyraclostrobin 20% WG) on chlorophyll content using SPAD meter at different stages in soybean genotypes.

Treatments	Days after spray														
	0					7					14				
	V ₁	V ₂	V ₃	V ₄	Mean	V ₁	V ₂	V ₃	V ₄	Mean	V ₁	V ₂	V ₃	V ₄	Mean
T ₁ - Control	32.47	36.43	32.20	33.53	33.66	41.40	42.30	40.63	42.53	41.72	41.63	46.53	41.00	41.83	42.75
T ₂ - 150 g/ac	34.17	36.40	32.50	34.10	34.29	47.07	50.73	46.30	47.93	48.01	48.73	55.73	47.30	49.43	50.30
T ₃ - 175 g/ac	34.87	37.00	33.40	35.50	35.19	49.73	52.93	48.53	50.43	50.41	50.20	58.13	50.53	51.63	52.62
T ₄ - 200 g/ac	35.07	37.50	33.50	35.73	35.45	52.53	55.63	52.00	53.80	53.49	53.43	63.33	51.83	56.53	56.28
Mean	34.15	36.83	32.90	34.72	34.65	47.68	50.40	46.87	48.67	48.40	48.50	55.93	47.67	49.86	50.49
For comparing means of	SEM±		CD at 5%			SEM±		CD at 5%			SEM±		CD at 5%		
Varieties (V)	0.21		0.61			0.21		0.60			0.27		0.79		
Treatments (T)	0.21		0.61			0.21		0.60			0.27		0.79		
Interaction (V×T)	0.42		NS			0.42		1.20			0.55		1.58		

V₁: JS-335 V₂: KHSb-2 V₃: DSb-1 V₄: DSb-11 NS: Non-significant

Table 2 Continued.

Treatments	Days after spray														
	21					28					35				
	V ₁	V ₂	V ₃	V ₄	Mean	V ₁	V ₂	V ₃	V ₄	Mean	V ₁	V ₂	V ₃	V ₄	Mean
T ₁ - Control	46.27	51.70	45.07	46.07	47.28	43.10	45.47	41.50	44.53	43.65	40.40	42.33	39.90	41.00	40.91
T ₂ - 150 g/ac	57.47	59.80	56.27	56.77	57.58	50.67	53.80	51.40	51.93	51.95	45.67	50.63	45.57	46.47	47.09
T ₃ - 175 g/ac	60.17	62.17	59.00	61.27	60.65	53.23	54.30	52.10	54.43	53.52	47.20	51.13	46.20	47.70	48.06
T ₄ - 200 g/ac	64.57	67.87	62.47	66.40	65.33	55.57	58.23	53.50	57.20	56.13	50.50	55.77	47.40	52.93	51.65
Mean	57.12	60.39	55.70	57.63	57.71	50.64	52.95	49.63	52.02	51.31	45.94	49.97	44.77	47.03	46.93
For comparing means of	SEM±		CD at 5%			SEM±		CD at 5%			SEM±		CD at 5%		
Varieties (V)	0.29		0.83			0.19		0.56			0.29		0.82		
Treatments (T)	0.29		0.83			0.19		0.56			0.29		0.82		
Interaction (V×T)	0.58		1.66			0.39		1.11			0.57		1.65		

V₁: JS-335 V₂: KHSb-2 V₃: DSb-1 V₄: DSb-11 NS: Non-significant

Table 3 : Effect of strobilurin (pyraclostrobin 20% WG) on superoxide dismutase activity (Δ SOD g of protein min⁻¹) different stages in soybean genotypes.

Treatments	Days after spray														
	0					7					14				
	V ₁	V ₂	V ₃	V ₄	Mean	V ₁	V ₂	V ₃	V ₄	Mean	V ₁	V ₂	V ₃	V ₄	Mean
T ₁ - Control	9.05	9.01	9.04	9.06	9.04	10.07	10.53	10.01	10.09	10.18	8.23	8.89	8.15	8.25	8.38
T ₂ - 150 g/ac	9.09	9.02	9.06	9.09	9.07	11.25	11.92	11.23	11.32	11.43	9.10	8.89	9.08	9.17	9.06
T ₃ - 175 g/ac	9.09	9.04	9.06	9.10	9.07	11.50	12.08	11.49	11.56	11.66	9.35	8.89	9.22	9.39	9.21
T ₄ - 200 g/ac	9.10	9.04	9.07	9.11	9.08	11.71	12.33	11.57	11.75	11.84	9.51	8.89	9.46	9.54	9.35
Mean	9.08	9.03	9.06	9.09	9.07	11.13	11.72	11.08	11.18	11.28	9.05	8.89	8.98	9.09	9.00
For comparing means of	SEM±		CD at 5%			SEM±		CD at 5%			SEM±		CD at 5%		
Varieties (V)	0.070		NS			0.074		0.213			0.070		0.201		
Treatments (T)	0.070		NS			0.074		0.213			0.070		0.201		
Interaction (V×T)	0.139		NS			0.147		NS			0.139		NS		

V₁: JS-335 V₂: KHSb-2 V₃: DSb-1 V₄: DSb-11 NS: Non-significant

Table 3 continued.

Treatments	Days after spray														
	21					28					35				
	V ₁	V ₂	V ₃	V ₄	Mean	V ₁	V ₂	V ₃	V ₄	Mean	V ₁	V ₂	V ₃	V ₄	Mean
T ₁ - Control	6.40	7.89	6.31	6.46	6.77	2.53	3.54	2.40	2.56	2.76	1.02	1.68	1.01	1.03	1.19
T ₂ - 150 g/ac	7.09	8.91	6.88	7.10	7.50	2.80	3.96	2.71	2.82	3.07	1.09	1.89	1.08	1.10	1.29
T ₃ - 175 g/ac	7.22	9.00	7.05	7.25	7.63	2.87	4.02	2.75	2.90	3.14	1.10	1.90	1.09	1.12	1.30
T ₄ - 200 g/ac	7.29	9.08	7.06	7.32	7.69	2.91	4.05	2.78	2.93	3.17	1.12	1.93	1.10	1.14	1.32
Mean	7.00	8.72	6.83	7.03	7.39	2.78	3.89	2.66	2.80	3.03	1.08	1.85	1.07	1.10	1.28
For comparing means of	SEM±		CD at 5%			SEM±		CD at 5%			SEM±		CD at 5%		
Varieties (V)	0.072		0.209			0.076		0.219			0.071		0.206		
Treatments (T)	0.072		0.209			0.076		0.219			0.071		NS		
Interaction (V×T)	0.144		NS			0.152		NS			0.143		NS		

V₁: JS-335 V₂: KHSb-2 V₃: DSb-1 V₄: DSb-11 NS: Non-significant

Table 4 : Effect of strobilurin (pyraclostrobin 20% WG) on ascorbic acid content (mg/g fresh weight) at different stages in soybean genotypes.

Treatments	Days after spray														
	0					7					14				
	V ₁	V ₂	V ₃	V ₄	Mean	V ₁	V ₂	V ₃	V ₄	Mean	V ₁	V ₂	V ₃	V ₄	Mean
T ₁ - Control	215.3	200.7	211.5	215.7	210.9	228.5	224.3	225.2	229.5	226.9	257.1	245.3	250.4	257.5	252.6
T ₂ - 150 g/ac	215.6	201.1	212.0	216.1	211.1	290.2	280.7	280.7	285.4	284.3	332.7	306.6	321.3	334.6	323.8
T ₃ - 175 g/ac	215.8	201.3	211.9	216.2	211.1	296.8	287.6	286.0	299.6	292.5	345.8	311.0	333.0	347.2	334.3
T ₄ - 200 g/ac	216.0	201.2	212.3	216.8	211.6	305.1	301.1	291.9	307.5	301.4	352.2	320.1	333.5	354.9	340.2
Mean	215.4	201.1	211.9	216.2	211.2	280.2	273.4	271.0	280.5	276.3	322.0	295.8	309.6	323.6	312.7
For comparing means of	SEM±		CD at 5%			SEM±		CD at 5%			SEM±		CD at 5%		
Varieties (V)	0.41		1.18			0.43		1.23			0.39		1.12		
Treatments (T)	0.41		NS			0.43		1.23			0.39		1.12		
Interaction (V×T)	0.82		NS			0.85		2.45			0.78		2.25		

V₁: JS-335 V₂: KHSb-2 V₃: DSb-1 V₄: DSb-11 NS: Non-significant

Table 4 continued.

Treatments	Days after spray														
	21					28					35				
	V ₁	V ₂	V ₃	V ₄	Mean	V ₁	V ₂	V ₃	V ₄	Mean	V ₁	V ₂	V ₃	V ₄	Mean
T ₁ - Control	243.7	230.2	238.8	244.7	239.4	220.8	204.1	210.3	221.4	214.2	209.3	203.5	205.6	210.2	207.2
T ₂ - 150 g/ac	312.9	291.0	304.1	315.0	305.8	255.2	245.0	243.9	256.7	250.2	240.7	238.8	239.7	242.5	240.4
T ₃ - 175 g/ac	321.3	298.8	313.5	320.4	313.5	258.5	246.8	248.3	260.2	253.5	244.2	239.5	241.1	245.3	242.5
T ₄ - 200 g/ac	335.6	310.7	324.9	337.9	327.3	264.7	251.6	251.2	266.3	258.5	246.9	241.4	242.9	248.1	244.8
Mean	303.4	282.7	295.3	304.5	296.5	249.8	236.9	238.4	251.2	244.1	235.3	230.8	232.3	236.5	233.7
For comparing means of	SEM±		CD at 5%			SEM±		CD at 5%			SEM±		CD at 5%		
Varieties (V)	0.37		1.07			0.39		1.14			0.38		1.10		
Treatments (T)	0.37		1.07			0.39		1.14			0.38		1.10		
Interaction (V×T)	0.74		2.13			0.79		2.28			0.76		NS		

V₁: JS-335 V₂: KHSb-2 V₃: DSb-1 V₄: DSb-11 NS: Non-significant

Table 5 : Effect of strobilurin (pyraclostrobin 20% WG) on phenol content (mg/g fr. wt) at different stages in soybean genotypes.

Treatments	Days after spray														
	0					7					14				
	V ₁	V ₂	V ₃	V ₄	Mean	V ₁	V ₂	V ₃	V ₄	Mean	V ₁	V ₂	V ₃	V ₄	Mean
T ₁ - Control	1.094	0.976	1.016	1.094	1.046	1.095	0.996	1.104	1.102	1.074	1.180	1.171	1.349	1.178	1.220
T ₂ - 150 g/ac	1.094	0.977	1.016	1.095	1.046	1.279	1.185	1.293	1.280	1.259	1.415	1.400	1.405	1.412	1.408
T ₃ - 175 g/ac	1.095	0.977	1.07	1.095	1.046	1.315	1.196	1.301	1.313	1.281	1.478	1.502	1.459	1.471	1.478
T ₄ - 200 g/ac	1.095	0.978	1.018	1.095	1.047	1.378	1.277	1.379	1.376	1.353	1.534	1.523	1.523	1.527	1.527
Mean	1.095	0.977	1.017	1.095	1.046	1.267	1.164	1.269	1.268	1.242	1.402	1.399	1.434	1.397	1.408
For comparing means of	SEM±		CD at 5%			SEM±		CD at 5%			SEM±		CD at 5%		
Varieties (V)	0.005		0.014			0.007		0.021			0.022		NS		
Treatments (T)	0.005		NS			0.007		0.021			0.022		0.064		
Interaction (V×T)	0.010		NS			0.014		NS			0.045		NS		

V₁: JS-335 V₂: KHSb-2 V₃: DSb-1 V₄: DSb-11 NS: Non-significant

Table 5 continued.

Treatments	Days after spray														
	21					28					35				
	V ₁	V ₂	V ₃	V ₄	Mean	V ₁	V ₂	V ₃	V ₄	Mean	V ₁	V ₂	V ₃	V ₄	Mean
T ₁ - Control	1.252	1.210	1.241	1.240	1.236	1.148	1.101	1.125	1.137	1.128	1.110	1.101	1.100	1.108	1.105
T ₂ - 150 g/ac	1.504	1.471	1.350	1.348	1.418	1.316	1.297	1.313	1.311	1.309	1.278	1.285	1.267	1.293	1.281
T ₃ - 175 g/ac	1.520	1.559	1.358	1.355	1.448	1.327	1.311	1.326	1.329	1.323	1.291	1.306	1.290	1.285	1.293
T ₄ - 200 g/ac	1.613	1.588	1.439	1.440	1.520	1.355	1.393	1.390	1.376	1.379	1.325	1.380	1.305	1.303	1.328
Mean	1.472	1.457	1.347	1.346	1.406	1.287	1.276	1.289	1.288	1.285	1.251	1.268	1.241	1.247	1.252
For comparing means of	SEM±		CD at 5%			SEM±		CD at 5%			SEM±		CD at 5%		
Varieties (V)	0.008		0.023			0.007		NS			0.039		NS		
Treatments (T)	0.008		0.023			0.007		0.022			0.039		0.113		
Interaction (V×T)	0.016		0.045			0.015		NS			0.078		NS		

V₁: JS-335 V₂: KHSb-2 V₃: DSb-1 V₄: DSb-11 NS: Non-significant

Table 6 : Effect of strobilurin (pyraclostrobin 20% WG) on nitrate reductase activity ($\mu\text{mol NO}_2$ g fr/wt/h) at different stages in soybean genotypes.

Treatments	Days after spray														
	0					7					14				
	V ₁	V ₂	V ₃	V ₄	Mean	V ₁	V ₂	V ₃	V ₄	Mean	V ₁	V ₂	V ₃	V ₄	Mean
T ₁ - Control	215.2	201.0	211.1	214.4	210.6	230.0	224.3	225.4	230.9	227.7	259.8	247.8	251.2	250.5	252.3
T ₂ - 150 g/ac	215.5	201.2	212.3	214.9	210.8	284.2	280.9	282.8	289.3	284.3	338.1	309.2	322.0	332.0	325.3
T ₃ - 175 g/ac	216.8	202.1	213.4	215.1	211.9	295.5	286.3	284.7	297.1	290.9	345.7	313.7	330.4	346.3	334.0
T ₄ - 200 g/ac	217.1	202.0	213.6	215.2	212.0	306.7	300.1	290.0	307.6	301.1	353.5	320.3	334.2	354.1	340.5
Mean	216.2	201.6	212.6	214.9	211.3	279.1	272.9	270.7	281.2	276.0	324.3	297.8	309.5	320.7	313.1
For comparing means of	SEM±		CD at 5%			SEM±		CD at 5%			SEM±		CD at 5%		
Varieties (V)	0.37		1.08			0.50		1.44			0.39		1.13		
Treatments (T)	0.37		1.08			0.50		1.44			0.39		1.13		
Interaction (V×T)	0.75		NS			1.00		2.89			0.78		2.26		

V₁: JS-335 V₂: KHSb-2 V₃: DSb-1 V₄: DSb-11 NS: Non-significant.

Table 6. Continued.

Treatments	Days after spray														
	21					28					35				
	V ₁	V ₂	V ₃	V ₄	Mean	V ₁	V ₂	V ₃	V ₄	Mean	V ₁	V ₂	V ₃	V ₄	Mean
T ₁ - Control	244.1	230.0	238.6	240.2	238.2	220.1	207.2	211.3	218.2	214.2	211.7	202.6	201.2	210.8	206.6
T ₂ - 150 g/ac	313.0	291.2	304.2	312.8	305.3	257.8	245.1	244.7	250.8	249.6	240.6	238.2	227.7	238.4	236.2
T ₃ - 175 g/ac	323.9	296.0	313.6	325.4	314.7	260.7	246.9	248.6	259.3	253.9	245.3	239.7	229.4	246.9	240.3
T ₄ - 200 g/ac	336.2	310.4	324.9	338.3	327.5	265.0	250.3	251.5	267.1	258.5	247.0	241.3	230.6	248.6	241.9
Mean	304.3	281.9	295.3	304.2	296.4	250.9	237.4	239.0	248.9	244.0	236.2	230.5	222.2	236.2	231.3
For comparing means of	SEM±		CD at 5%			SEM±		CD at 5%			SEM±		CD at 5%		
Varieties (V)	0.43		1.25			0.42		1.21			0.43		1.23		
Treatments (T)	0.43		1.25			0.42		1.21			0.43		1.23		
Interaction (V×T)	0.87		2.50			0.84		2.43			0.85		2.46		

V₁: JS-335 V₂: KHSb-2 V₃: DSb-1 V₄: DSb-11 NS: Non-significant.

Table 7 : Effect of strobilurin (pyraclostrobin 20% WG) on yield parameters in soybean genotypes.

Treatments	No. of pods/plant					No. of seeds/pod					100 Seed weight(g)				
	V ₁	V ₂	V ₃	V ₄	Mean	V ₁	V ₂	V ₃	V ₄	Mean	V ₁	V ₂	V ₃	V ₄	Mean
T ₁ - Control	34.6	39.8	33.1	36.5	36.0	2.1	1.6	1.7	2.3	1.9	11.88	9.56	11.25	12.86	11.39
T ₂ - 150 g/ac	40.4	45.5	39.0	41.8	41.7	2.3	1.7	1.8	2.4	2.1	12.90	10.39	11.89	14.37	12.39
T ₃ - 175 g/ac	41.5	46.3	39.5	42.2	42.4	2.5	1.8	2.0	2.6	2.2	13.34	11.10	12.93	14.51	12.97
T ₄ - 200 g/ac	42.9	47.8	41.2	44.6	44.1	2.6	2.0	2.1	2.6	2.3	14.96	11.87	13.65	15.83	14.08
Mean	39.9	44.9	38.2	41.3	41.0	2.4	1.8	1.9	2.5	2.1	13.27	10.73	12.43	14.39	12.71
For comparing means of	SEm±		CD at 5%			SEm±		CD at 5%			SEm±		CD at 5%		
Varieties (V)	0.86		2.48			0.04		0.11			0.18		0.53		
Treatments (T)	0.86		2.48			0.04		0.11			0.18		0.53		
Interaction (V×T)	1.72		NS			0.08		NS			0.36		NS		

V₁: JS-335 V₂: KHSb-2 V₃: DSb-1 V₄: DSb-11 NS: Non-significant

Table 8 : Effect of strobilurin (pyraclostrobin 20% WG) on yield in soybean genotypes.

Treatments	Seed yield/plant(gplant ⁻¹)					Seed yield(qha ⁻¹)				
	V ₁	V ₂	V ₃	V ₄	Mean	V ₁	V ₂	V ₃	V ₄	Mean
T ₁ - Control	10.15	8.45	9.95	10.96	9.88	32.38	25.69	30.85	33.98	30.73
T ₂ - 150 g/ac	11.26	9.27	10.38	12.15	10.77	34.24	27.00	33.67	36.27	32.80
T ₃ - 175 g/ac	11.55	10.16	11.49	12.88	11.52	36.04	29.48	34.19	38.44	34.54
T ₄ - 200 g/ac	12.77	10.90	12.23	13.55	12.36	38.23	30.70	36.52	39.87	36.33
Mean	11.43	9.70	11.01	12.39	11.13	35.22	28.22	33.81	37.14	33.60
For comparing means of	SEm±		CD at 5%			SEm±		CD at 5%		
Varieties (V)	0.23		0.68			1.03		2.97		
Treatments (T)	0.23		0.68			1.03		2.97		
Interaction (V×T)	0.47		NS			2.06		NS		

V₁: JS-335 V₂: KHSb-2 V₃: DSb-1 V₄: DSb-11 NS: Non-significant

Table 9 : Effect of strobilurin (pyraclostrobin 20% WG) on per cent increase in seed yield (q ha⁻¹) over control in soybean genotypes.

Treatments	Varieties				
	V ₁	V ₂	V ₃	V ₄	Mean
T ₁ - Control	—	—	—	—	—
T ₂ - 150 g/ac	5.74	5.09	9.14	6.73	6.68
T ₃ - 175 g/ac	11.30	14.75	10.82	13.12	12.50
T ₄ - 200 g/ac	18.06	19.50	18.37	17.33	18.32
Mean	11.70	13.11	12.78	12.39	12.50

V₁: JS-335 V₂: KHSb-2 V₃: DSb-1 V₄: DSb-11

pyraclostrobin increased superoxide scavenging SOD activity in soybean leaves. Similar results were observed by Jabs and Tiedemann (2002) in barley. SOD activity was maximum at 7 DAS and further reduced from 14 DAS to 35 DAS in all the treatments and in all the

varieties. Among the varieties the SOD was maximum in KHSb-2 followed by DSb-11 and lowest activity was recorded in DSb-1.

There was slight increase in ascorbic acid content due to strobilurin in all the genotypes and it was increased from 0 to 21 DAS and declined at 28 and 35 DAS. Among the treatments, strobilurin @ 200 g/ac recorded significantly higher ascorbic acid content as compared to control and it decreased with decrease in the concentration of strobilurin. In all the stages, DSb-11 recorded maximum ascorbic acid content and lowest was recorded in KHSb-2.

Phenols have major biological properties like anti-microbial activity and are often assumed that their main role in plants is to act as protective compounds against disease causing agents such as fungi, bacteria and viruses. DSb-1 recorded maximum phenol content at 7,

14 and 28 DAS and lowest was observed in KHSb-2 at 7, 28 DAS. The extent of increase of phenol content was more between 7 and 14 DAS.

Application of strobilurin exhibited significant differences in nitrate reductase activity (NRA) in leaf. The enzyme nitrate reductase (NR) catalyses the reduction of nitrate to nitrite (Beevers and Hageman, 1969) and is a rate limiting step in nitrogen metabolism. Increased concentration of strobilurin increased the NRA activity and it was maximum at strobilurin @ 200 g/ac. NRA was maximum at 14 DAS and decreased later on. NR is a key enzyme in nitrogen metabolism and its activity should always be higher to have higher nitrogenous compounds in plants. It is generally believed that NRA depends on the activity of substrates and proteinaceous compounds. Glaab and Kaiser (1999) found that higher yields in plants due to strobilurin application is attributed to increased nitrate reductase activity.

Seed yield and its related parameters were influenced by the application of different concentrations of strobilurin (pyraclostrobin) at 150, 175 and 200 g/ac in four genotypes. It was indicated that strobilurin has differential influence on the allocation of assimilates between vegetative and reproductive organs. In general, crop yield depends on the accumulation of photo-assimilates during the growing period and the way they are partitioned between desired storage organs of plant. In the present study, it was revealed that the application of strobilurin (pyraclostrobin) significantly increased the number of seeds, number of pods, 100 seed weight and finally seed yield per plant, which are the most important yield determining components in soybean. With respect to

genotypes, DSb-11 recorded significantly highest yield parameters like number of pods per plant, number of seeds per pod and 100 seed weight, whereas the genotype KHSb-2 recorded highest pods per plant.

Conclusion

Among the treatments, strobilurin @ 200 g/ac exhibited superiority over rest of the treatments, while giving a better response to most of the yield contributing characters such as higher photosynthetic rate, higher chlorophyll content, higher SOD activity, higher ascorbic acid content, higher phenol content and more NRA. Ultimately resulting into more number of pods per plant, more number of seeds per pod, 100 seed weight and thus resulting in higher seed yield.

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