

1 **Supplementary files**
2 **Table S1.** Optimized coefficients used in the genotype file of CROPGRO for blackgram varieties after calibration
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Genotypes	CSDL	PPSEN	EM-FL	FL-SH	FL-SD	SD-PM	FL-LF	LFMAX	SLAVR	SIZLF	XF RT	WTPSD	SFDUR	SDPDV	PODUR	THRS H	SDPR O	SDLI P
ECOTYPE – ANDDET																		
Original genetic coefficient (VAR# A 195)																		
	12.17	0.020	28	2.5	9.2	21.50	12.0	0.99	300	160	1	0.550	17.5	3.5	11.0	78	0.235	0.03
Calibrated genetic coefficients																		
DBG-5	12.17	0.0122	34.83	2.5	12.86	18.36	13.2	0.98	330	160	1	0.605	22	3.85	12.10	78	0.235	0.03
DBG-19	12.17	0.0175	35	2.5	12.78	18.96	13.2	0.98	330	160	1	0.605	22	3.85	12.10	78	0.235	0.03
DBG-31	12.17	0.0146	35	2.5	12.86	19.03	13.2	0.98	330	160	1	0.605	22	3.85	12.10	78	0.235	0.03
DBG-33	12.17	0.0175	35	2.5	12.78	18.07	13.2	0.995	330	160	1	0.605	21.09	3.85	12.10	78	0.235	0.03
DBG-34	12.17	0.0175	35	2.5	12.78	18.96	13.2	0.995	330	160	1	0.605	21	3.85	12.10	78	0.235	0.03
DBG-93	12.17	0.0146	35	2.5	12.86	19.03	13.2	1.0	330	160	1	0.605	18.7	3.85	12.10	78	0.235	0.03
DBG-16	12.17	0.0175	35	2.5	12.63	19.10	13.2	0.98	330	160	1	0.605	22	3.85	12.10	78	0.235	0.03
DBG-96	12.17	0.0115	34.39	2.5	13	21.41	13.2	0.98	330	160	1	0.605	21.34	3.85	12.10	78	0.235	0.03
DBG-90	12.17	0.0100	34.42	2.5	12.66	18.55	13.2	0.98	330	160	1	0.605	22	3.85	12.10	78	0.235	0.03
DBG-95	12.17	0.0115	34.39	2.5	13	19.60	13.2	0.98	330	160	1	0.605	22	3.85	12.10	78	0.235	0.03
DBG-61	12.17	0.0144	34.2	2.5	12.78	22.66	13.2	0.98	330	160	1	0.605	20.87	3.85	12.10	78	0.235	0.03
DU-1	12.17	0.0175	35	2.5	12.78	18.07	13.2	0.98	330	160	1	0.605	21.35	3.85	12.10	78	0.235	0.03

4 **Coefficient code and Genetic Coefficient Description (units):** CSDL- Critical short day length (in hr) below which reproductive development proceeds unaffected by day length in short-day plants
5 (in hr), PPSEN- Slope of the relative developmental response to photoperiod over time (positive for short day plants) (1 hr⁻¹), EM-FL- Duration from plant emergence to flower appearance (photothermal
6 days), FL-SH- Duration from first flower to first pod (photothermal days), FL-SD- Duration from first flower to first seed (photothermal days), SD-PM- Duration from first seed to physiological maturity
7 (photothermal days), FL-LF- Duration from first flower to end of leaf expansion (photothermal days), LFMAX- Maximum leaf photosynthesis rate (mg CO₂ m⁻² s⁻¹), SLAVR- Specific leaf area of cultivar
8 under standard growth conditions (cm² g⁻¹), SIZLF- Maximum size of full leaf (3 leaflets) (cm²), XFRT- Maximum fraction of daily growth that is partitioned to seed + shell, WTPSD- Maximum weight per
9 seed (mg), SFDUR- Seed filling duration for pod cohort at standard growth conditions (photothermal days), SDPDV- Average seed per pod under standard growing conditions (#/pod), PODUR- Time
10 required for cultivar to reach final pod load under optimal conditions (photothermal days), THRS- Maximum seed-to-total pod weight ratio at maturity (%), SDPRO- Seed protein fraction (g(protein)
11 g⁻¹(seed)), SDLIP- Seed oil fraction (g(oil) g⁻¹(seed)) (15).

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20 **Table S2.** Calibrated and validated values for days to anthesis and physiological maturity of different genotypes across sowing dates

Genotypes	Sowing date	Calibration 2022		Validation 2022
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		Days to anthesis			Days to physiological maturity			Sowing date	Days to anthesis			Days to physiological maturity		
		Simulated	Observed	% D	Simulated	Observed	% D		Simulated	Observed	% D	Simulated	Observed	% D
DBG-5	30-May	43	43	0	77	77	0	13-June	42	43	-2.3	77	79	-2.5
	27-June	43	43	0	77	76	1.3	18-July	43	42	2.4	77	76	1.3
	Average	43	43	0	77	77	0	Average	43	43	0	77	78	-1.3
DBG-19	30-May	43	43	0	78	79	-1.3	13-June	43	43	0	78	80	-2.5
	27-June	44	44	0	78	78	0	18-July	43	43	0	78	77	1.3
	Average	44	44	0	78	79	-1.3	Average	43	43	0	78	79	-1.3
DBG-31	30-May	43	43	0	78	79	-1.3	13-June	42	42	0	78	79	-1.3
	27-June	44	45	-2.2	78	77	1.3	18-July	43	43	0	78	77	1.3
	Average	44	44	0	78	78	0	Average	43	43	0	78	78	0
DBG-33	30-May	43	42	2.4	77	77	0	13-June	43	43	0	77	78	-1.3
	27-June	44	44	0	77	77	0	18-July	43	44	-2.3	77	76	1.3
	Average	44	43	2.3	77	77	0	Average	43	44	-2.3	77	77	0
DBG-34	30-May	43	41	5	78	79	-1.3	13-June	43	44	-2.3	78	80	-2.5
	27-June	44	44	0	78	78	0	18-July	43	43	0	78	77	1.3
	Average	44	43	2.3	78	79	-1.3	Average	43	44	-2.3	78	79	-1.3
DBG-93	30-May	43	43	0	78	79	-1.3	13-June	42	42	0	78	78	0
	27-June	44	44	0	78	78	0	18-July	43	42	2.3	78	78	0
	Average	44	44	0	78	79	-1.3	Average	43	42	2.4	78	78	0
DBG-16	30-May	43	42	2.4	78	78	0	13-June	43	43	0	78	79	-1.3
	27-June	44	45	-2.2	78	77	1.3	18-July	43	44	-2.3	78	78	0
	Average	44	44	0	78	78	0	Average	43	44	-2.3	78	79	-1.3
DBG-96	30-May	42	42	0	80	82	-2.4	13-June	42	43	-2.3	80	82	-2.4
	27-June	43	43	0	80	80	0	18-July	43	43	0	80	79	1.3
	Average	43	43	0	80	81	-1.2	Average	43	43	0	80	81	-1.2
DBG-90	30-May	42	41	2.4	77	77	0	13-June	42	42	0	76	76	0
	27-June	43	44	-2.3	77	77	0	18-July	43	43	0	77	76	1.3
	Average	43	43	0	77	77	0	Average	43	43	0	77	76	1.3
DBG-95	30-May	42	42	0	78	79	-1.3	13-June	42	43	-2.3	78	80	-2.5
	27-June	43	43	0	78	78	0	18-July	43	44	-2.3	78	77	1.3
	Average	43	43	0	78	79	-1.3	Average	43	44	-2.3	78	79	-1.3
DBG-61	30-May	42	41	2.4	81	82	-1.2	13-June	42	43	-2.3	81	82	-1.2
	27-June	43	43	0	81	80	1.3	18-July	42	42	0	81	80	1.3
	Average	43	42	2.4	81	81	0	Average	42	43	-2.3	81	81	0
DU-1	30-May	43	42	2.4	77	77	0	13-June	43	43	0	77	79	-2.5
	27-June	44	44	0	77	76	1.3	18-July	43	43	0	77	76	1.3
	Average	44	43	2.3	77	77	0	Average	43	43	0	77	78	-1.3

Table S3. Calibrated and validated values for grain yield of different genotypes at harvest maturity

Treatments	Sowing date	Calibration 2022			Sowing date	Validation 2022		
		Simulated	Observed	% D		Simulated	Observed	% D
DBG-5	30-May	2801	2788	0.5	13-June	2876	2769	4
	27-June	2746	2728	1	18-July	2785	2582	8
	Average	2774	2758	0.6	Average	2831	2676	5.8
DBG-19	30-May	2927	2876	2	13-June	2830	2836	-0.2
	27-June	2818	2829	-0.4	18-July	2910	2678	9
	Average	2873	2853	0.7	Average	2870	2757	4.1
DBG-31	30-May	2899	2958	-2	13-June	2968	2948	1
	27-June	2778	2899	-4	18-July	2889	2721	6
	Average	2839	2929	-3.1	Average	2929	2835	3.3
DBG-33	30-May	2833	2882	-2	13-June	2742	2848	-4
	27-June	2729	2782	-2	18-July	2835	2624	8
	Average	2781	2832	-1.8	Average	2789	2736	1.9
DBG-34	30-May	2960	3016	-2	13-June	2872	2978	-4
	27-June	2848	2892	-2	18-July	2943	2735	8
	Average	2904	2954	-1.7	Average	2908	2857	1.8
DBG-93	30-May	2971	3029	-2	13-June	3068	3108	-1
	27-June	2849	2912	-2	18-July	2976	2807	6
	Average	2910	2971	-2.1	Average	3022	2958	2.2
DBG-16	30-May	2983	2903	3	13-June	2869	2889	-1
	27-June	2855	2838	1	18-July	2934	2680	9
	Average	2919	2871	1.7	Average	2902	2785	4.2
DBG-96	30-May	3191	3208	-1	13-June	3171	3178	-0.2
	27-June	3061	3152	-3	18-July	3077	2913	6
	Average	3126	3180	-1.7	Average	3124	3046	2.6
DBG-90	30-May	2950	2922	1	13-June	2795	2902	-4
	27-June	2831	2843	-0.4	18-July	2817	2694	5
	Average	2891	2883	0.3	Average	2806	2798	0.3
DBG-95	30-May	2963	2870	3	13-June	2968	2930	1
	27-June	2827	2848	-1	18-July	2865	2739	5
	Average	2895	2859	1.3	Average	2917	2835	2.9
DBG-61	30-May	3349	3425	-2	13-June	3278	3361	-2
	27-June	3231	3258	-1	18-July	3310	3098	7
	Average	3290	3342	-1.6	Average	3294	3230	2.0
DU-1	30-May	2814	2823	-0.3	13-June	2717	2806	-3
	27-June	2710	2782	-3	18-July	2814	2602	8
	Average	2762	2803	-1.5	Average	2766	2704	2.3

% D = Percent deviation, Simulated- Predicted values obtained from the DSSAT-CROPGRO model, Observed- Actual values recorded from field experiments

Table S4. Genotype-wise model evaluation statistics for phenology and yield of blackgram genotypes during calibration and validation

Genotypes	Calibration									Validation								
	Days to anthesis			Days to physiological maturity			Grain yield (kg ha ⁻¹)			Days to anthesis			Days to physiological maturity			Grain yield (kg ha ⁻¹)		
	RMSE	NRMSE	d	RMSE	NRMSE	d	RMSE	NRMSE	d	RMSE	NRMSE	d	RMSE	NRMSE	d	RMSE	NRMSE	d
DBG-5	0	0	1	0	0	1	16.97	0.62	0.998	0.71	1.65	0.944	1	1.28	0.944	107.2	4	0.962
DBG-19	0	0	1	0.71	0.91	0.957	35.36	1.24	0.992	0	0	1	1	1.27	0.944	91.92	3.33	0.970
DBG-31	0.71	1.61	0.944	0.71	0.91	0.957	85.56	2.92	0.943	0	0	1	0.71	0.91	0.957	94.35	3.33	0.964
DBG-33	0.71	1.63	0.944	0	0	1	35.36	1.25	0.992	1	2.33	0.917	0.71	0.92	0.957	113.14	4.13	0.953
DBG-34	1	2.33	0.917	0.71	0.91	0.957	42.43	1.43	0.991	1	2.33	0.917	1	1.27	0.944	113.14	3.96	0.956
DBG-93	0	0	1	0.71	0.91	0.957	42.43	1.43	0.991	0.71	1.65	0.944	0	0	1	85.56	2.89	0.973
DBG-16	0.71	1.63	0.944	0	0	1	42.43	1.48	0.991	1	2.33	0.917	0.71	0.89	0.957	127.28	4.57	0.944
DBG-96	0	0	1	1.41	1.75	0.889	63.64	2	0.976	0.71	1.65	0.944	1	1.24	0.944	109.09	3.58	0.961
DBG-90	0.71	1.65	0.944	0	0	1	42.43	1.47	0.991	0	0	1	0.71	0.92	0.957	78.1	2.79	0.975
DBG-95	0	0	1	0.71	0.91	0.957	42.43	1.48	0.991	1	2.33	0.917	1	1.27	0.944	91.92	3.24	0.969
DBG-61	0.71	1.69	0.944	0.71	0.88	0.957	63.64	1.9	0.976	1	2.38	0.917	0	0	1	113.14	3.5	0.961
DU-1	0.71	1.65	0.944	0	0	1	28.28	1.01	0.995	0	0	1	1	1.28	0.944	127.28	4.71	0.943

RMSE= root-mean-square error, NRMSE = normalized root-mean-square error, d = Index of agreement. Ratings are as follows: Excellent- NRMSE <10 % of mean observed; Good- 10 % < NRMSE < 20 %; Satisfactory- 20 % < NRMSE < 30 %; Unsatisfactory- NRMSE > 30 %. Very good- d ≥ 0.9; Good- d ranges between 0.80-0.89; Moderate good- d ranges between 0.25-0.49; Very poor- d < 0.25 (18).

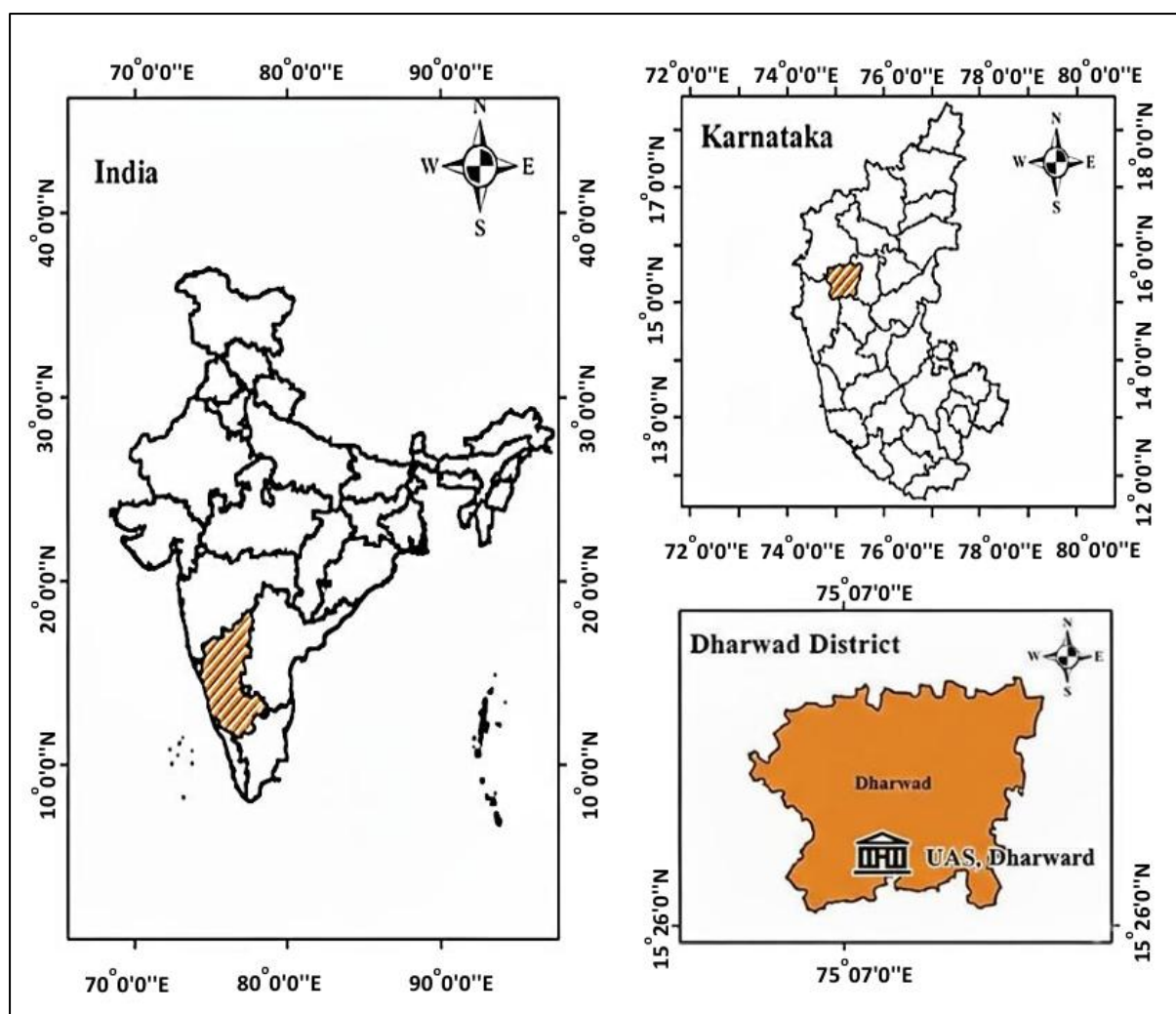


Figure S1. Location map of the experimental site in Dharwad, Karnataka.

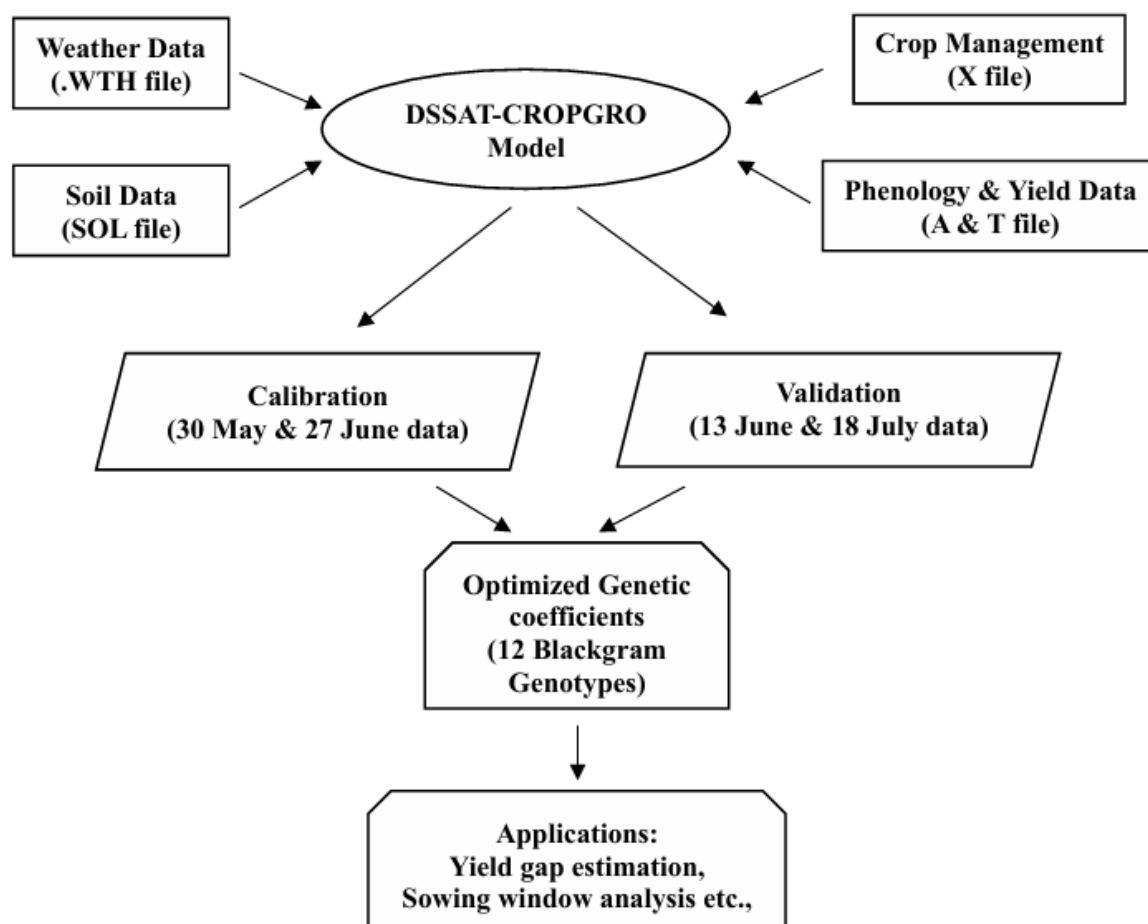


Figure S2. Schematic diagram of DSSAT-CROPGRO model application.