Estimation of Input Use Efficiency in Rice Production Using INFOCROP Model

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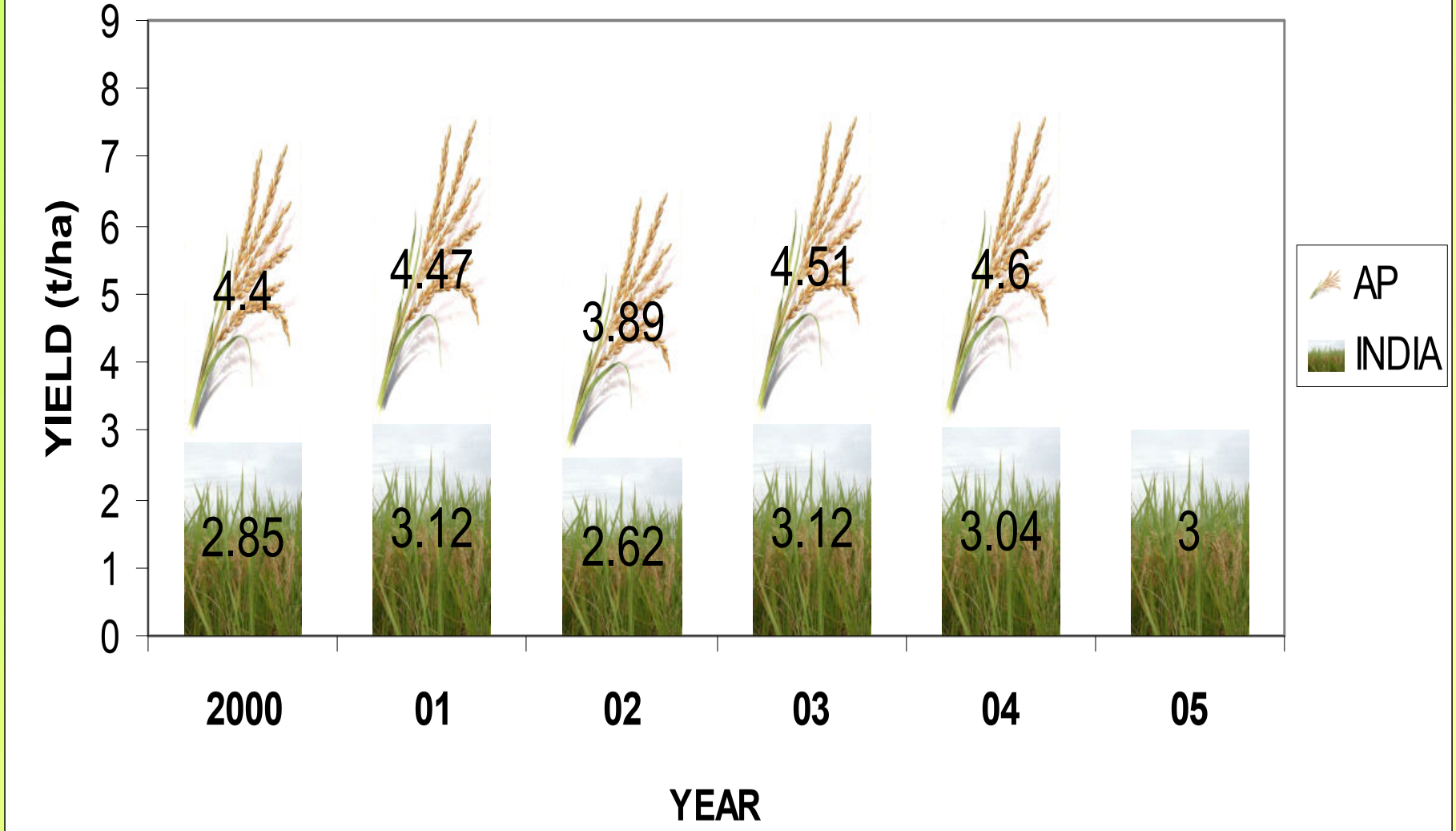
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Fig.1a: Overall view of field experimental plot

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Rice Productivity



Experimental details: The relevant details are

Crop : Rice
Variety : BPT-5204
Gross plot size : 5.4 m x 4.5 m
Net plot size : 5.0 m x 4.2 m
Seed rate : 50 kg ha-1
Fertilizers : 120:60:40 N :P2O5 : K2O kg ha-1
Design : RBD with factorial concept
Season : *kharif, 2005*
Treatments : 6
Replication : 4

Treatments:

Factor 1 : Date of planting
1. D1-July 15
2. D2-July 30
3. D3-August 15

Factor 2 : Spacing
1. S1-15cm x 15 cm
2. S2-20 cm x15 cm

Table 1: Soil and management data required by InfoCrop

INPUT	UNIT
Soil characters (layer wise)	
Thickness of soil (TKL)	1.3m
Bulk density of soil (BDL)	1.73 g/m^3
Soil pH (PHSOL)	7.8
Soil organic carbon (SOC)	0.35%
Sand content (SAND)	66.4%
Volumetric water content	
Initial (WCL)	8.10%
Field capacity (WCFCM)	13.20%
Wilting point (WCWPM)	6.20%
Management DATA	
Sowing date (DATES)	* day of the year
Seed rate (SEEDRT)	50 kg ha^{-1}
Sowing depth (SOWDEP)	5cm
Irrigation method (IRRMET)	flooding
Nitrogen applied (NITROGEN)	120 kg N ha^{-1}

Table 2: Genotypic characteristics of BPT-5204 used in InfoCrop

Genetic constants	Unit	Value
Thermal time for	degree	
Sowing to germination	days	80
Germination to 50% flowering	degree	1450
50% flowering to physiological	days	510
maturity	degree	
Base temperature for	days	
Sowing to germination	ºC	7.6
Germination to 50% flowering	ºC	9
50% flowering to physiological	ºC	9
maturity		
Optimum temperature for	ºC	30
development		
Maximum temperature for	ºC	39
development		
Sensitivity to photo period	Fraction	1

Evaluation of model

$$MAE = \sum_{i=1}^{n} [Pi - Oi] / n$$

$$MBE = \sum_{i-1}^{n} (Pi - Oi) / n$$

$$RMSE = \left[\sum_{i=1}^{n} (Pi - Oi)^2 / n \right]^{1/2}$$

$$D = 1 - \left[\sum_{i=1}^{n} (Pi - Oi) / \sum_{i=1}^{n} (IP'iI + IO'iI)^2 \right]$$

$$0 \leq (D) \leq 1$$

where ,

$$P'i = Pi - \overline{P}, O' = Oi - \overline{O}$$

Error % = {(simulated – observed) / observed} x 100

Other parameters used in the model

Relative growth rate of leaf area : 0.009 0C /d

Extinction coefficient of leaves at flowering (0.6 ha soil/ ha leaf fraction),

Radiation use efficiency: 2.3g /MJ/day

Root growth rate: 12 mm/day

Potential storage organ weight: 22 mg/grain

Nitrogen content of storage organ: 0.013

Slope of storage organ number /m2 to dry matter during storage organ formation: 58000 storage organ/kg/day

Sensitivity of storage organ setting to low and high temperature :1

Calibrated specific leaf area : 0.0028 m2/mg

Table 3: Effect of different dates of planting and spacing on grain yield of rice

Date of planting	**Grain yield (kg ha^{-1})**	**Spacing (cm)**	**Grain yield (kg ha^{-1})**
D_1 - July 15	5,530	S_1 -15x15	5,264
D_2 – July 30	5,173	S_2 -20x15	5,090
D_3 – August 15	4,829	-	-
S.Em.±	34	-	28
C.D (P= 0.05)	104	-	85
Interaction (Date of planting x Spacing)			
S.Em.±	49		
C.D (P= 0.05)	NS		

Fig.1: Temporal variation in maximum temperature during different sowing dates of *Kharif*, 2005

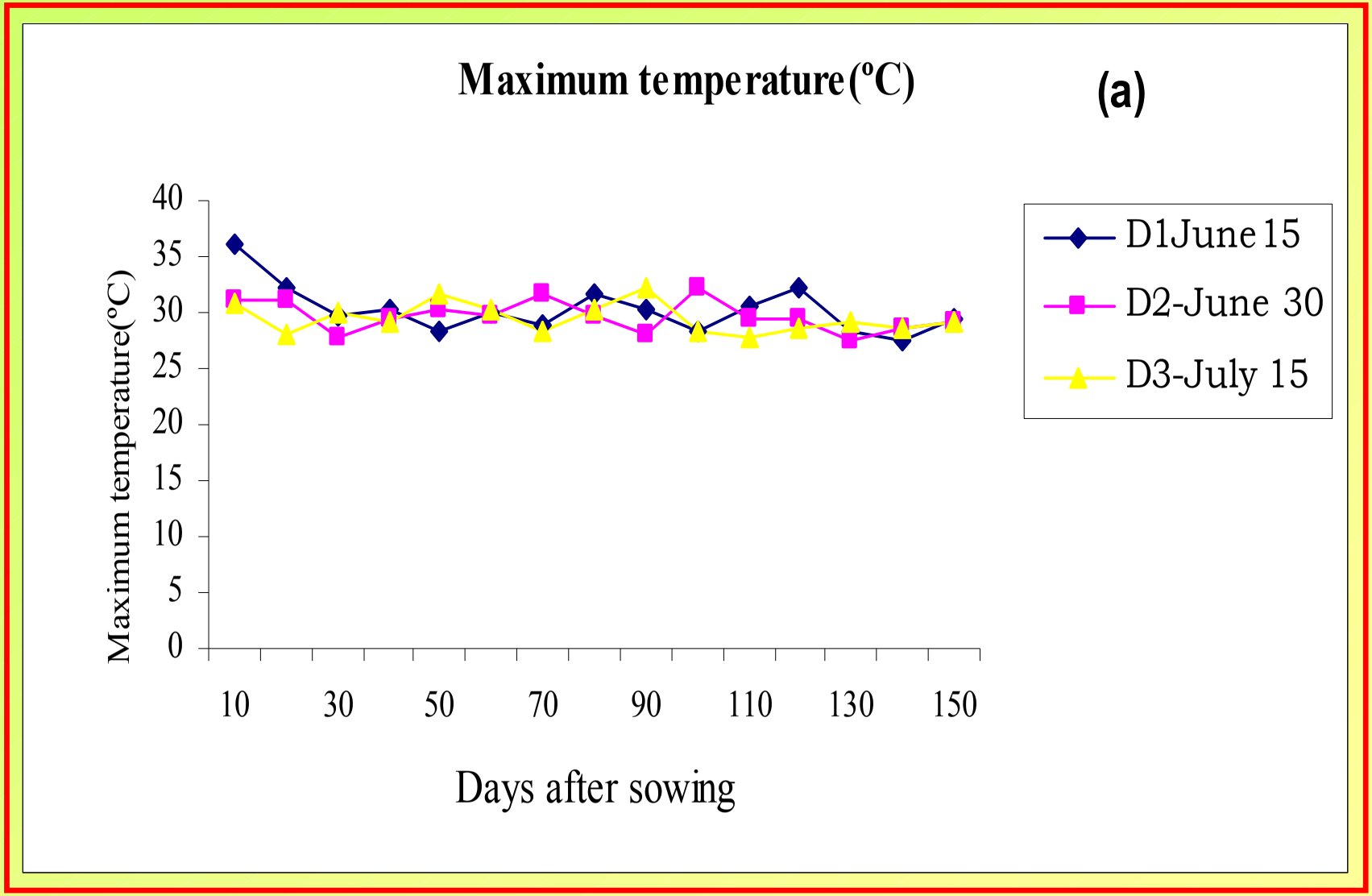


Table 4: Temporal variation in maximum temperature during different sowing dates of *Kharif*, 2005

Maximum Temperature (º C)			
Days	D1 July 15	D2 July 30	D3 Aug15
10	36.05	31.14	30.95
20	32.32	31.14	27.97
30	29.78	27.80	29.94
40	30.33	29.31	29.06
50	**28.39**	**30.17**	**31.79**
60	30.12	29.78	30.30
70	29.00	31.75	28.34
80	31.65	29.60	30.14
90	30.20	28.19	32.31
100	28.30	32.10	28.41
110	30.63	29.31	27.70
120	32.16	29.50	28.64
130	28.31	27.61	29.28
140	27.50	28.66	28.60

Fig.2: Temporal variation in sunshine hours during different sowing dates of *Kharif*, 2005

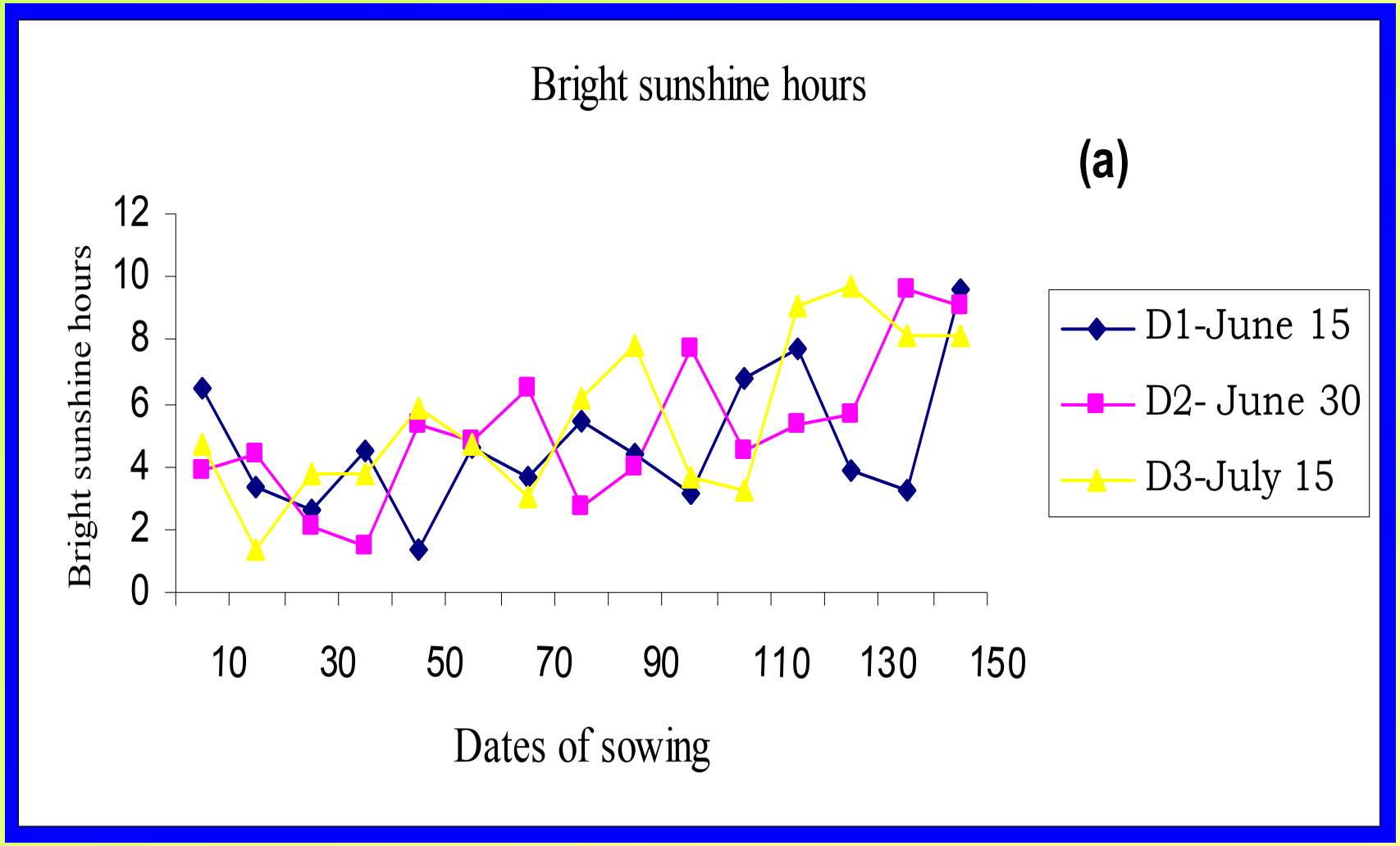


Table5: Temporal variation in sunshine hours during different sowing dates of *Kharif*, 2005

DAT	D1 July 15	D2 July 30	D3 Aug 15
10	6.46	3.84	4.74
20	3.31	4.36	1.34
30	2.65	2.10	3.75
40	**4.49**	1.46	3.75
50	1.39	5.31	5.85
60	4.58	4.76	4.72
70	3.63	6.50	3.00
80	**5.44**	2.70	6.11
90	4.37	4.01	7.87
100	3.11	7.70	3.62
110	**6.76**	4.52	3.26
120	**7.70**	5.37	8.08
130	3.81	5.63	8.10
140	3.19	8.65	8.09

Table 6: Test criteria in evaluation of InfoCrop with respect to rice yield (kg ha^{-1})

Parameter	value	Parameter	value
OMY*	5,181	MAE	630
SDo	320	MBE	-310
SMY*	4,870	RMSE	840
SDs	1,117	% of observed RMSE	16.2
r	0.86*		

* Significant at 5 per cent probability
MAE - Mean Absolute Error
MBE - Mean Bias Error
OMY* - Observed Mean Yield (kg ha-1)
SMY* - Simulated Mean Yield (kg ha-1)
SD - Standard Deviation

Fig. 3: Comparison of InfoCrop simulated yield with that observed in rice *kharif*, 2005

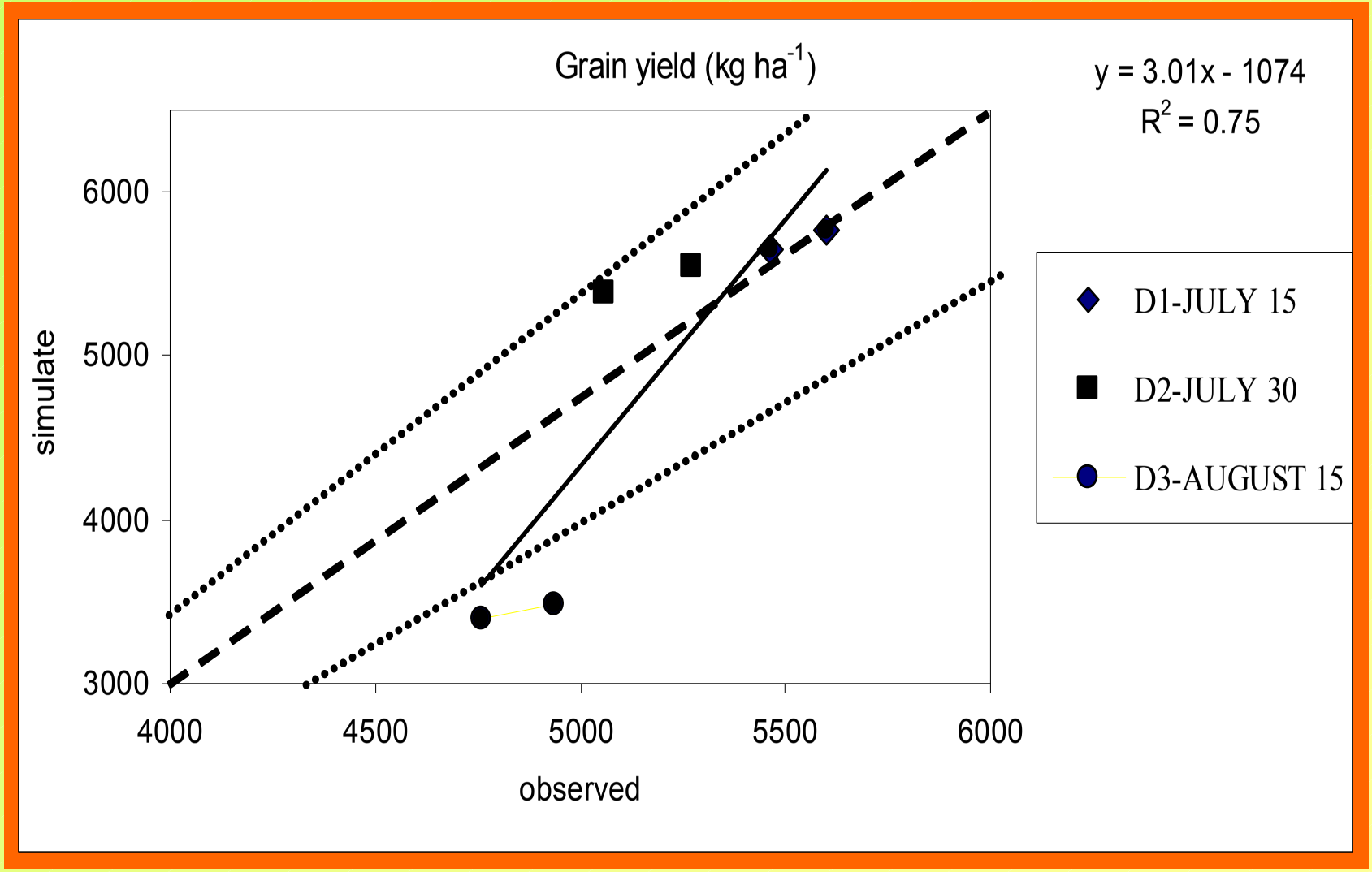


Table 7: Error per cent by INFOCROP simulated grain yield from observed in rice *kharif*, 2005

Treatment	**Error per cent * Spacings (cm)**	
Dates of planting	S_1 (15x15)	S_2 (20x15)
D_1 - July 15	2.88	3.41
D_2 – July 30	5.39	6.51
D_3 – August 15	-29.53	-28.69

*Error per cent =[(Simulated – Observed)/ Observed)]x 100

Table 8: Input use efficiency of time of planting and spacing in terms of economic returns in rice

Treatment	Gross returns (Rs. ha^{-1})		Cost of cultivation (Rs. ha^{-1})	Net returns (Rs. ha^{-1})		Profit per Rupee investment (Rs)	
Dates of planting	**Observed**	**Simulated**	**Observed**	**Observed**	**Simulated**	**Observed**	**Simulated**
D_1- July 15	36,264	38,320	11,845	24,419	26,475	2.06	2.23
D_2- July 30	33,835	36,447	11,845	21,990	24,602	1.85	2.07
D_3- Aug 15	31,659	23,230	11,845	19,814	11,385	1.67	0.96
Spacing (cm)							
S_1- 15 x 15	34,508	33,120	11,845	22,663	21,275	1.91	1.79
S_2- 20 x 15	33,290	32,213	11,845	21,445	20,368	1.81	1.71

Conclusions

Delay in planting by 15 days from July 15

Reduction in yield was 13.8 kg ha^{-1} per day

In conjunction with delay in planting, adoption of wider spacing further reduced the yield by 25 kg ha^{-1} per day

Delay in planting by 30 days from July 15

The magnitude of yield loss 76 kg ha^{-1} per day

Delayed planting time coupled with wider spacing the reduction in yield was 78.8 kg ha^{-1} per day


THANK YOU

Status of Rice production

Rice production in India declined drastically in 2003 (71.8 m t) as compared with the production in 2002 (93.3 m t), with the consolation of slight increase in 2004 (88. 3 m t).

Rice production in AP also decreased by 4.1 m t during the year 2003 -2004 as compared with that in the previous year (11.5 m t) but, with the deviation of an increase by 1.7 m t of rice production in 2004 -05 (9.0 m t).