Evaluation of the CSM-CROPGRO-Peanut Model in Simulating Growth and Phenological Development of Three Peanut Cultivars to Different Moisture Regimes

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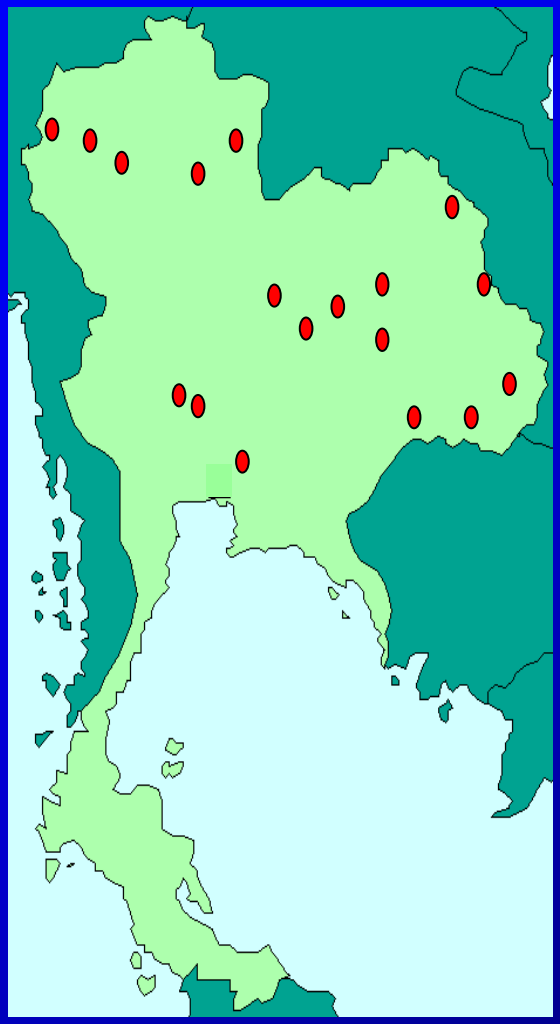
- In Thailand peanut is the economic crop, mostly grown under rainfed conditions



- Drought stress is common under rainfed growing conditions, but even under irrigation water deficit also often occurs during the growing season, resulting in some to substantial reduction in crop yield.

A number of management options could be used to alleviate the drought stress problem , e.g.

- **Choosing a suitable planting date**
- **Employing an effective irrigation management**
- **Using a drought resistant cultivar**

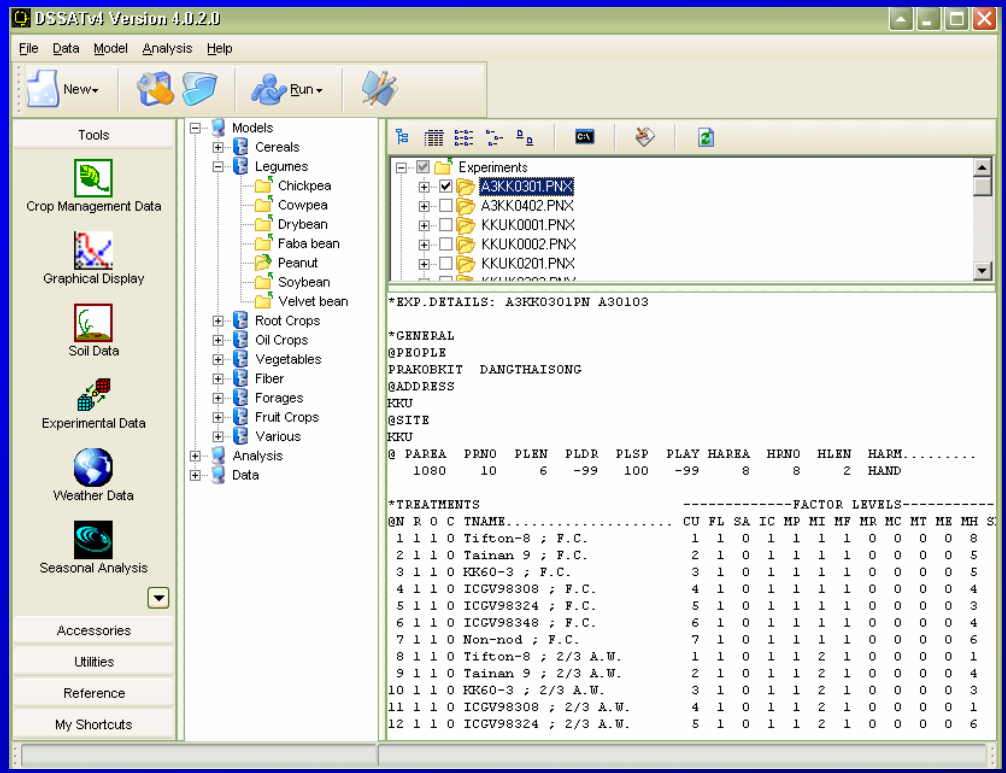
However, identifying the suitable crop management practices for each production area is time consuming and expensive process as it may involve many years of experimental data collection.

Currently, dynamic crop simulation models have been developed as a tool to support strategic decision making in research, production, land use and policy.

The CSM-CROPGRO-Peanut has been developed to simulate vegetative and reproductive development, growth and yield as a function of;

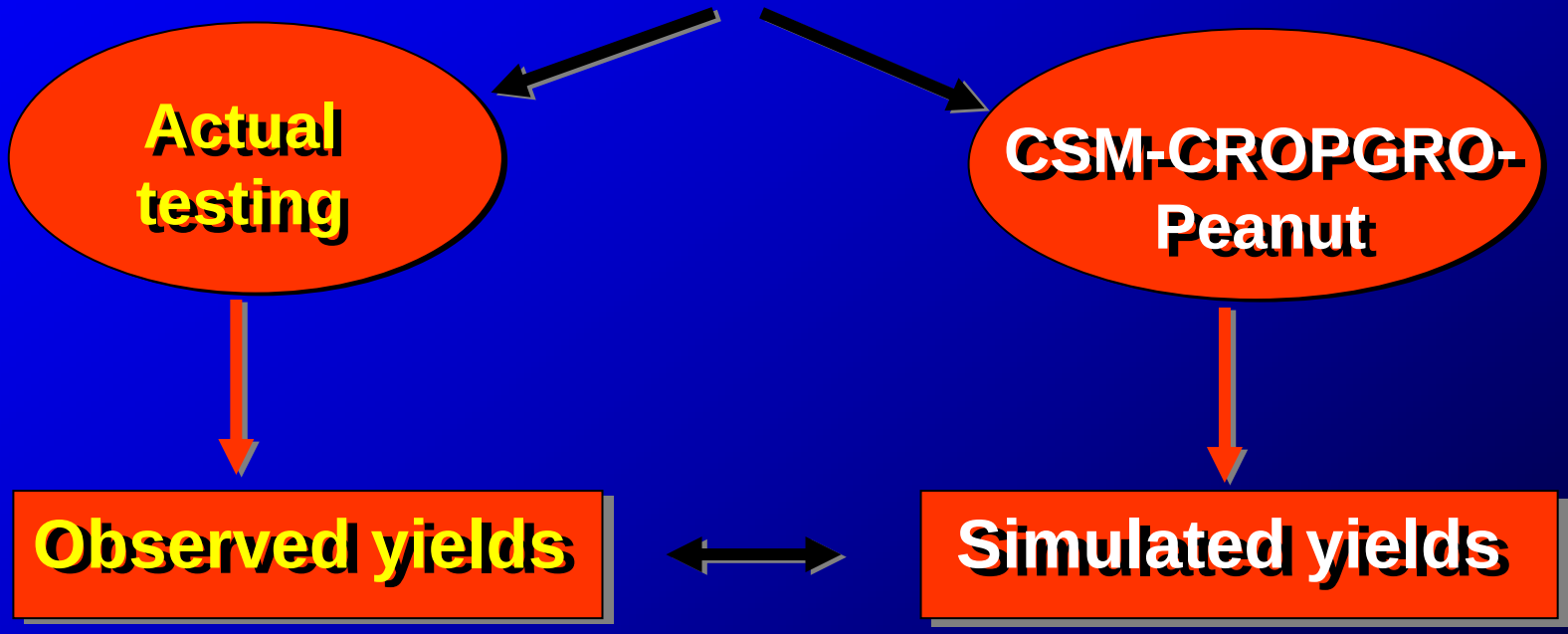
- **Crop characteristics**
- **Climatic factors**
- **Soil characteristics**
- **Crop management scenarios**

The objective of this study was to evaluate the capability of the CSM-CROPGRO-Peanut model in simulating the responses of three peanut cultivars to three levels of water regimes under controlled experimentation.



APPROACH

Three peanut cultivar grown under three soil moisture regimes



Compare agreement

Materials and methods

Field experiment :

The experiments were conducted at the Field Crops Research Station of Khon Kaen University in Khon Kaen province of northeast Thailand in the dry season of 2004 and repeated in the dry season of 2005.

The treatments included combinations of

Three levels of water regime, i.e.,
Field capacity (F.C.), 2/3 available water (2/3 A.W.) and 1/3 available water (1/3 A.W.)

Three peanut cultivars , i.e.,
Tifton- 8, Tainan 9 and Khon Kaen 60-3,

A split-plot in a randomized complete block design with four replications was used.

- After planting, the moisture level at 0-30 cm depth of all experimental plots was uniformly controlled at field capacity by drip irrigation.

- The three water-regime treatments were imposed to the individual main-plots by applying different amounts of irrigation water to the plots corresponding to the designated water regimes, starting at 14 days after emergence.

Fig. 1 Field experiment : water control meter (A), the peanut crop receiving field capacity (B) and at 1/3 available water (C)

Data collection :

- Plant development and growth
- soil characteristics
- Weather data
- Management data

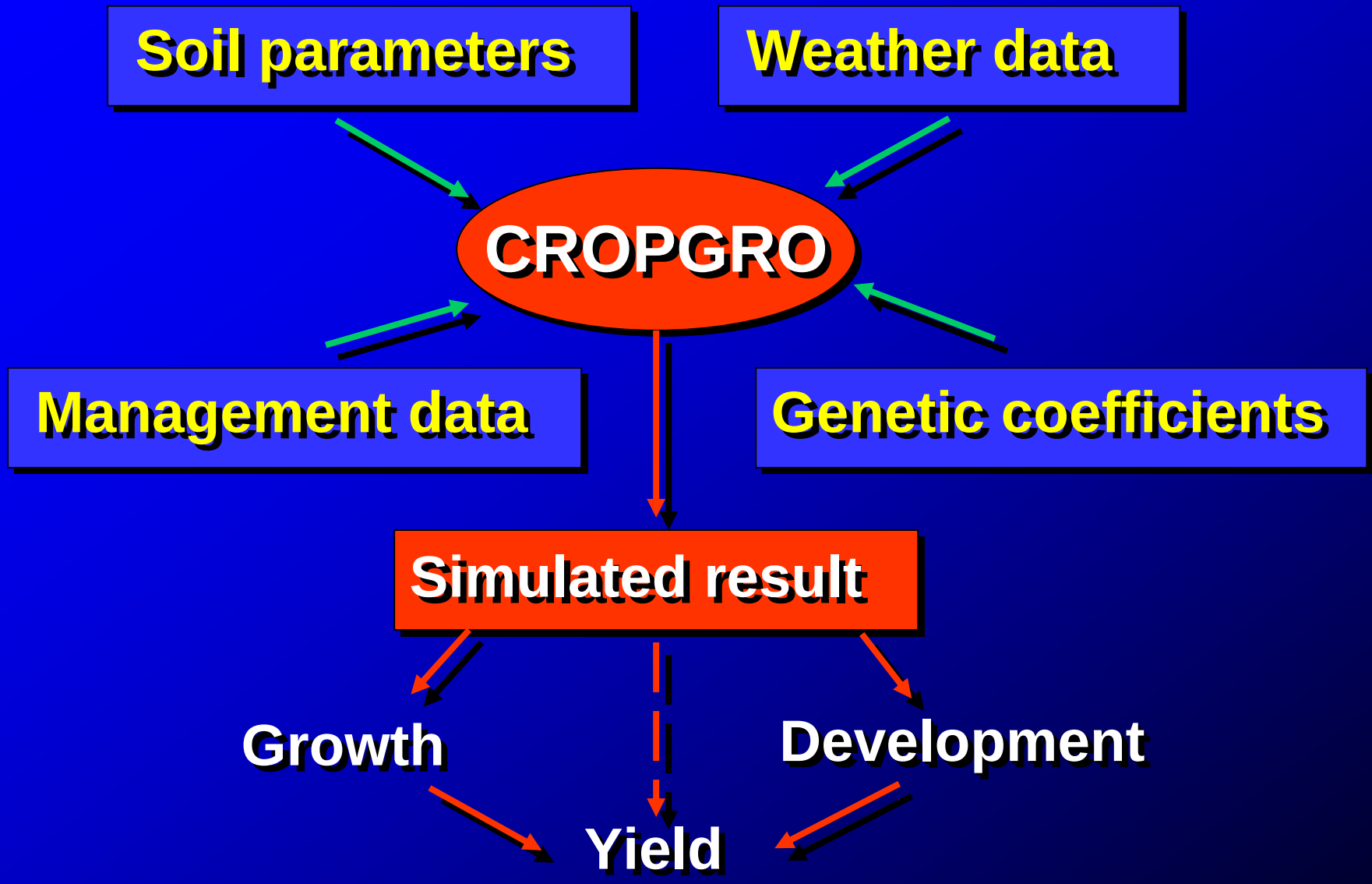
- **Plant development data included the dates on which 50 % of the plants reached flowering and maturity.**

- **Total biomass and pod dry weights were measured seven times at 15-day intervals, from 15 days after emergence until maturity.**

- Soil data collected included bulk density, percentages of sand, silt and clay, soil moisture, organic matter, pH, nitrate (NO_3^-) and (NH_4^+) concentrations, and exchangeable P and K.

- Weather data, e.g. daily maximum and minimum temperatures (^oC), rainfall (mm) and solar radiation ($MJ\ m^{-2}$).

- Management data recorded were row spacing, plant density, date of sowing, and dates and rates of fertilizer and irrigation.


Soil parameters
Weather data
CROPGRO
Management data
Genetic coefficients
Simulated result
Growth
Development
Yield

For the genetic coefficients

- Tainan 9 and KK 60-3 cultivars were obtained from Banterng et al. (2004) and Bhalang et al. (2006)

- Tifton-8 were obtained from data baes of DSSAT

- **Model evaluation was done by comparing the simulated values of development and growth characters with their corresponding observed values,**

- **By the values for root mean square error (RMSE) and The index of agreement (*d*)**

- **A low RMSE value and a *d-stat* value approaching unity are desirable**

RESULTS

Table 1 : Simulation (S) and Observation (O) days after planting to flowering date of three peanut cultivars grown under three soil moisture regimes in the dry seasons of 2004

Water levels	Cultivars	S	O±SD	S-O
F.C.	KK 60-3	33	31±3	2
2/3 A .W.	KK 60-3	33	33±3	0
1/3 A .W.	KK 60-3	33	32±2	1
F.C.	Tainan 9	33	29±4	4
2/3 A .W.	Tainan 9	33	31±3	2
1/3 A .W.	Tainan 9	33	29±3	4
F.C.	Tifton-8	38	36±5	2
2/3 A .W.	Tifton-8	38	36±3	2
1/3 A .W.	Tifton-8	38	37±2	1

Table 3 : Simulation (S) and Observation (O) days after planting to flowering date of three peanut cultivars grown under three soil moisture regimes in the dry seasons of 2005

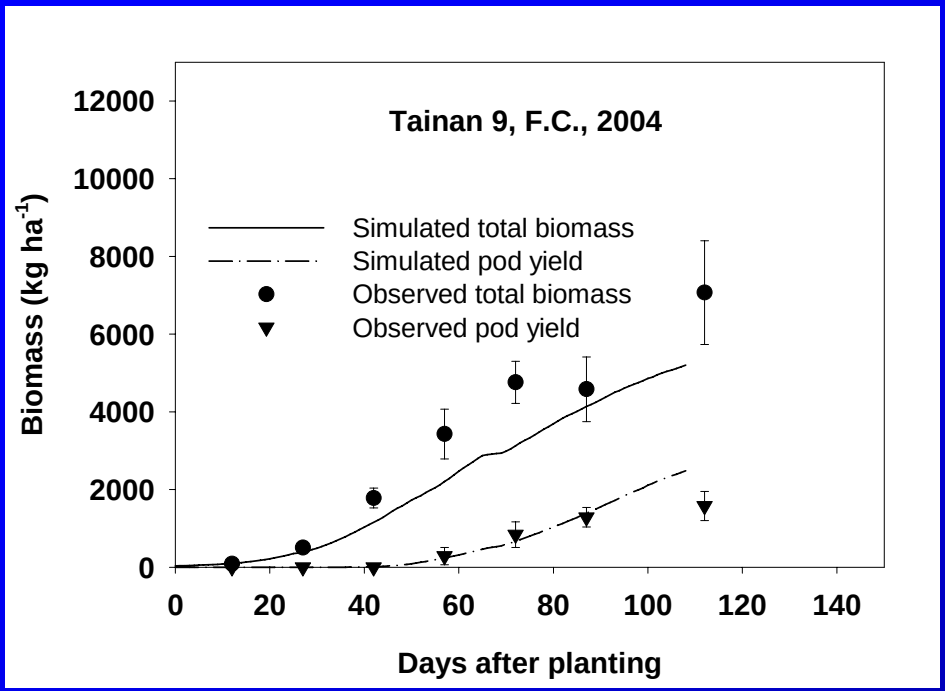
Water levels	Cultivars	S	O±SD	S-O
F.C.	KK 60-3	37	32±2	5
2/3 A .W.	KK 60-3	37	35±1	2
1/3 A .W.	KK 60-3	37	31±1	6
F.C.	Tainan 9	29	27±3	2
2/3 A .W.	Tainan 9	29	27±2	2
1/3 A .W.	Tainan 9	29	26±2	3
F.C.	Tifton-8	33	37±1	-4
2/3 A .W.	Tifton-8	33	38±3	-5
1/3 A .W.	Tifton-8	33	35±2	-2

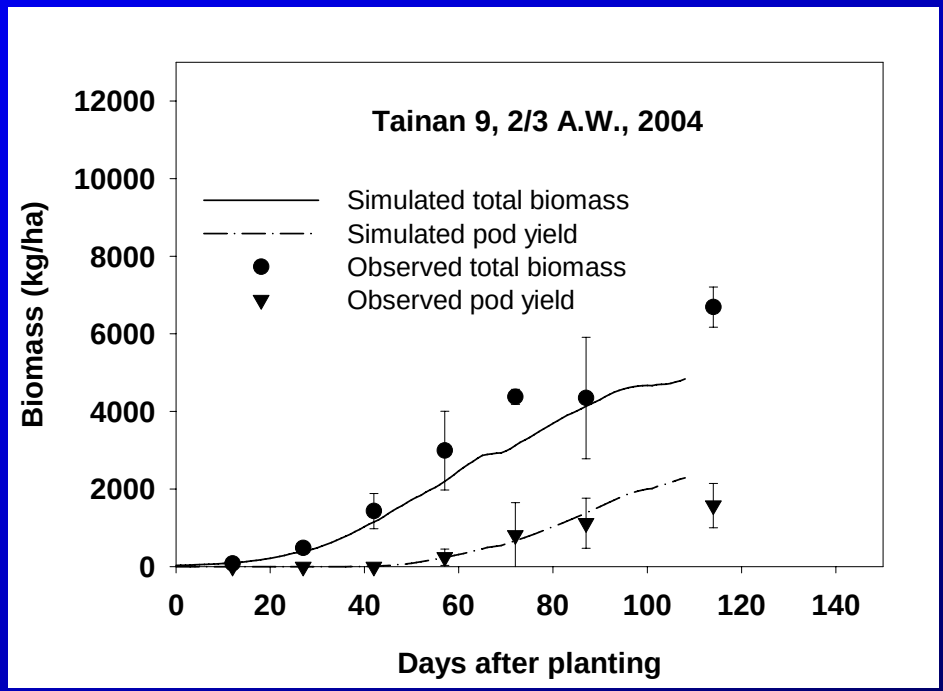
Table 2 : Simulation (S) and Observation (O) days after planting to maturity date of three peanut cultivars grown under three soil moisture regimes in the dry seasons of 2004

Water levels	Cultivars	S	O±SD	S-O
F.C.	KK 60-3	128	120±3	8
2/3 A .W.	KK 60-3	123	121±3	2
1/3 A .W.	KK 60-3	120	124±2	4
F.C.	Tainan 9	115	112±4	3
2/3 A .W.	Tainan 9	113	114±3	-1
1/3 A .W.	Tainan 9	113	117±3	-4
F.C.	Tifton-8	143	133±2	10
2/3 A .W.	Tifton-8	142	134±5	8
1/3 A .W.	Tifton-8	140	136±2	4

Table 4 : Simulation (S) and Observation (O) days after planting to maturity date of three peanut cultivars grown under three soil moisture regimes in the dry seasons of 2005

Water levels	Cultivars	S	O±SD	S-O
F.C.	KK 60-3	129	128+4	1
2/3 A .W.	KK 60-3	127	133+3	-6
1/3 A .W.	KK 60-3	125	136+3	11
F.C.	Tainan 9	114	114+0	0
2/3 A .W.	Tainan 9	111	117+3	-6
1/3 A .W.	Tainan 9	110	117+3	-7
F.C.	Tifton-8	144	133+2	11
2/3 A .W.	Tifton-8	138	134+5	4
1/3 A .W.	Tifton-8	135	136+2	-1





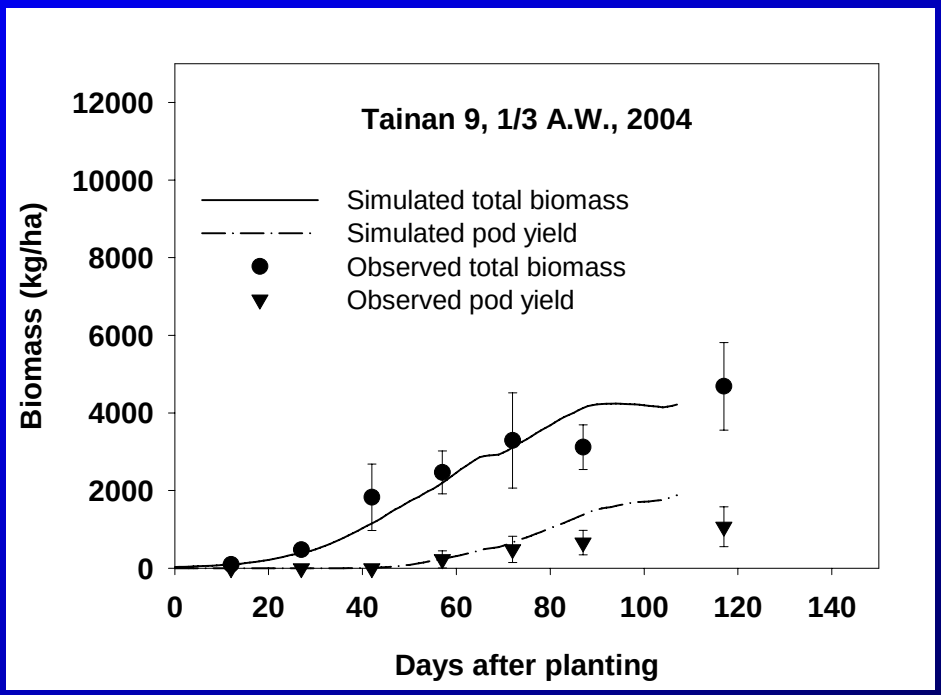
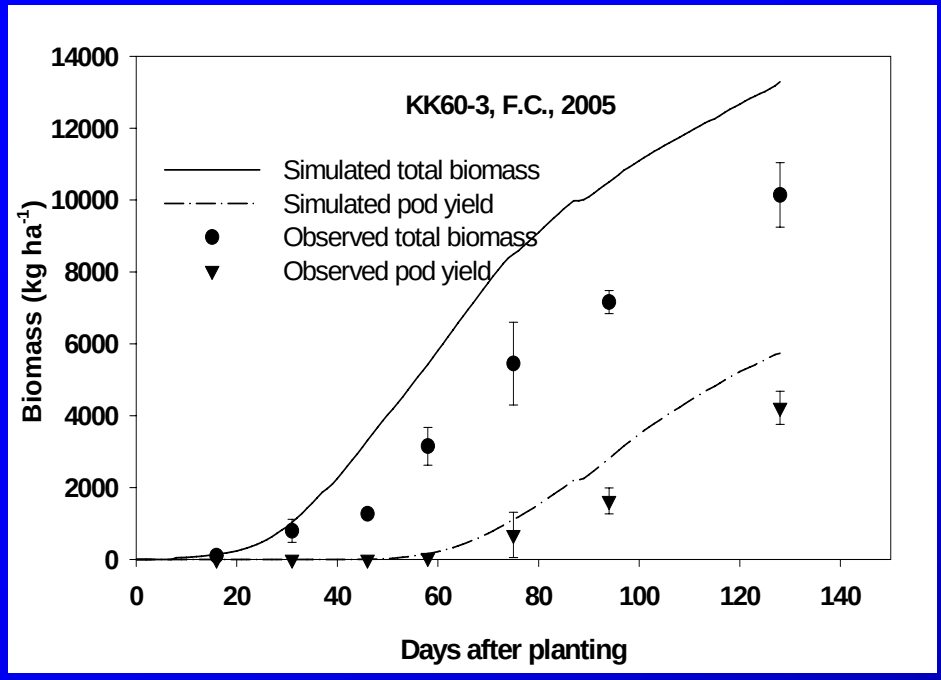
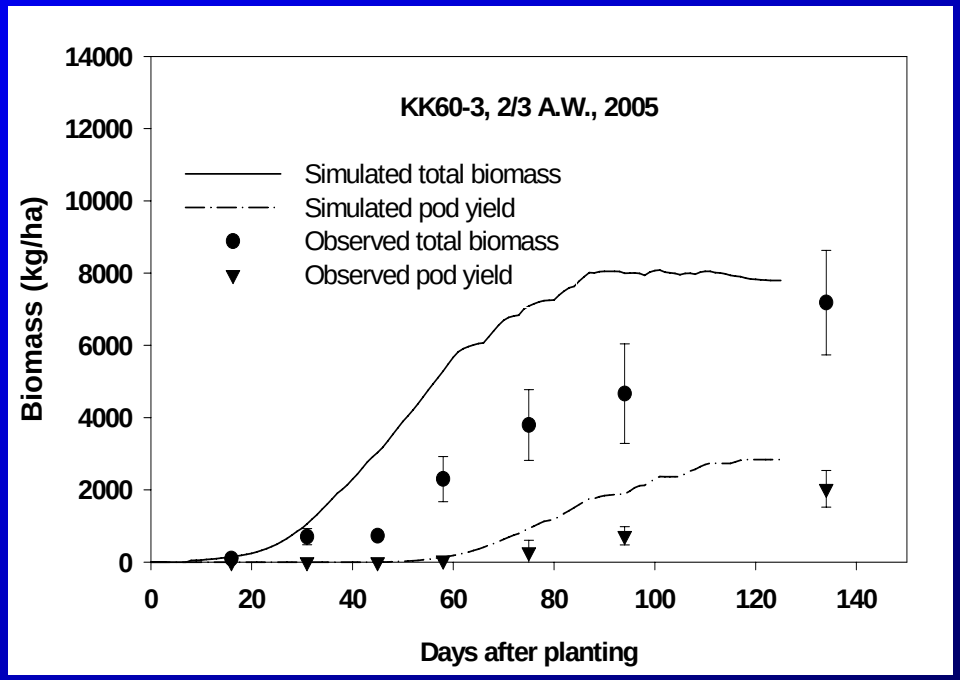


Fig. 2 : Simulated (line) and observed (point) values for total biomass and pod yield (kg/ha) of Tainan 9 for three moisture regimes in 2004

Table 5 : RMSE and D-stat for tatal biomass and pod yield for the dry season in 2004

Water levels	Cultivars	Total biomass		Pod yield	
		RMSE (kgha)	D-stat	RMSE (kgha)	D-stat
F.C.	KK 60-3	2287.5	0.90	689.5	0.91
2/3 A .W.	KK 60-3	2104.6	0.86	683.8	0.80
1/3 A .W.	KK 60-3	1961.2	0.82	450.9	0.76
F.C.	Tainan 9	1115.9	0.96	315.2	0.96
2/3 A .W.	Tainan 9	1688.5	0.83	169.2	0.97
1/3 A .W.	Tainan 9	1257.8	0.72	92.4	0.95
F.C.	Tifton-8	2316.4	0.90	1219.1	0.81
2/3 A .W.	Tifton-8	2101.6	0.85	610.7	0.84
1/3 A .W.	Tifton-8	1580.7	0.67	387.2	0.87





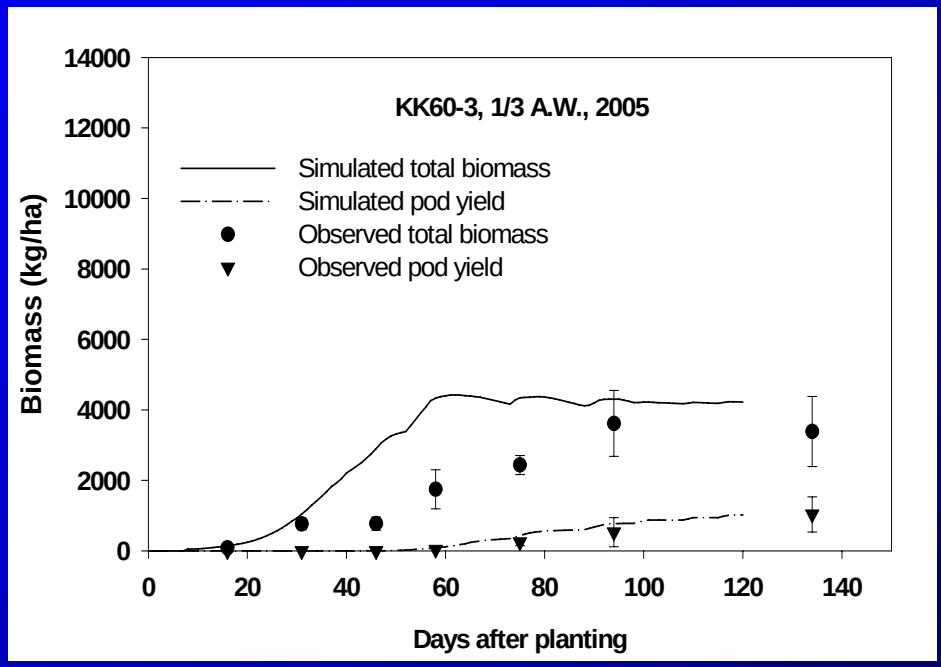
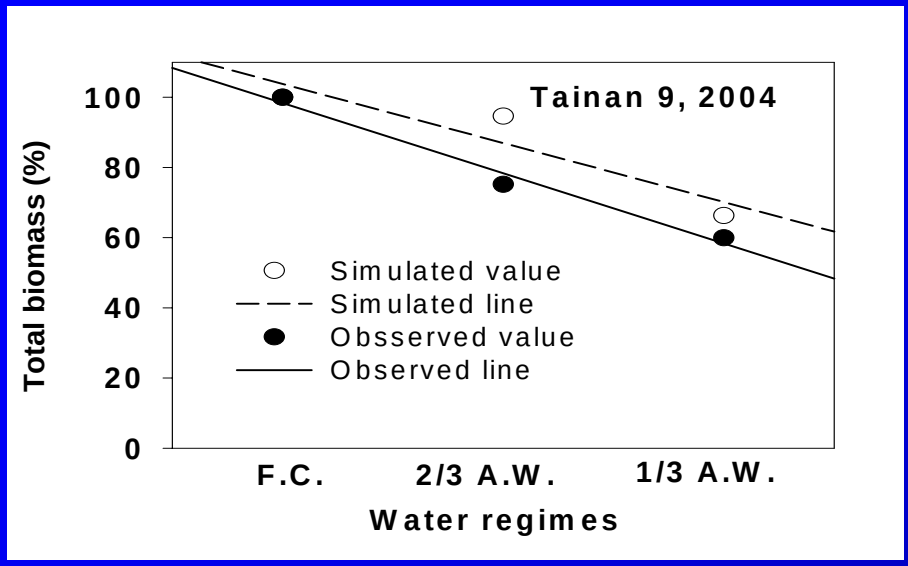


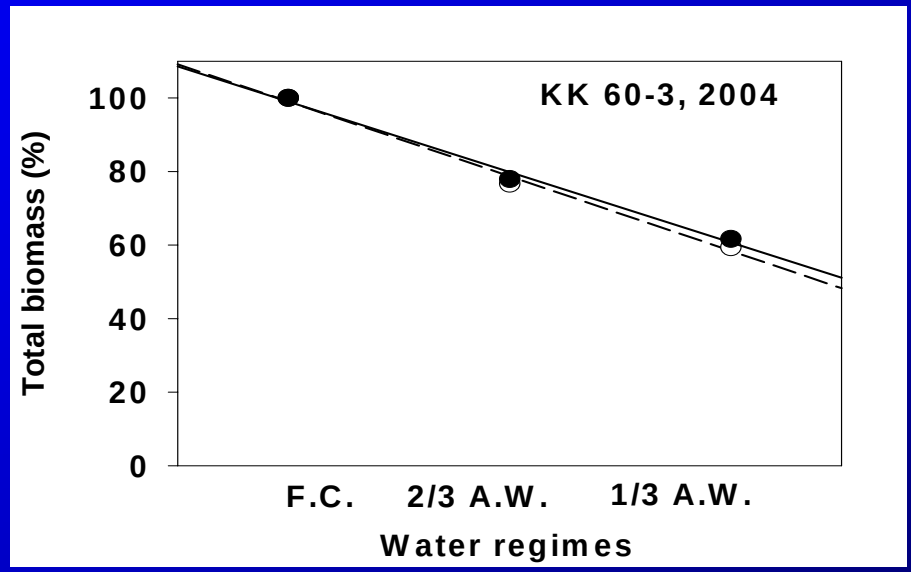
Fig. 6 : Simulated (line) and observed (point) values for total biomass and pod yield (kg/ha) of KK 60-3 for three moisture regimes in 2005

Table 6 : RMSE and D-stat for total biomass and pod yield for the dry season in 2005

Water levels	Cultivars	Total biomass		Pod yield	
		RMSE (kgha)	D-stat	RMSE (kgha)	D-stat
F.C.	KK 60-3	2826.5	0.83	1128.4	0.72
2/3 A .W.	KK 60-3	2854.6	0.71	1011.1	0.59
1/3 A .W.	KK 60-3	1767.6	0.69	258.4	0.77
F.C.	Tainan 9	1265.3	0.94	265.8	0.95
2/3 A .W.	Tainan 9	1200.1	0.91	145.5	0.96
1/3 A .W.	Tainan 9	1214.2	0.86	182.0	0.87
F.C.	Tifton-8	1234.1	0.95	595.1	0.84
2/3 A .W.	Tifton-8	1304.0	0.93	364.9	0.90
1/3 A .W.	Tifton-8	1364.4	0.89	373.6	0.78

In order to evaluate how well the model can simulates the relative responses of the three peanut cultivars to the three soil moisture regimes, pod yield and total biomass of each cultivar at 2/3 available water and at 1/3 available water were calculated as the percentage of their respective pod yield obtained from the F.C. moisture treatment.





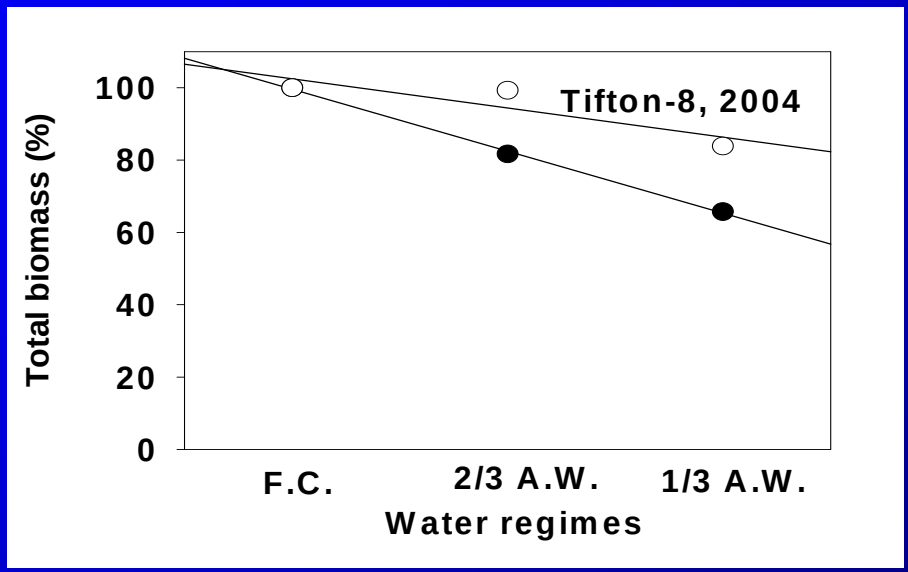
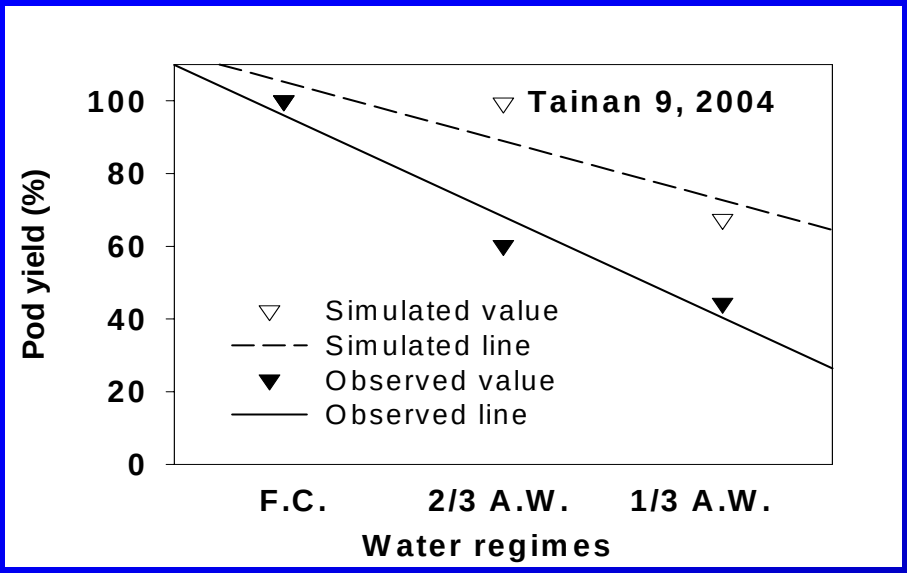
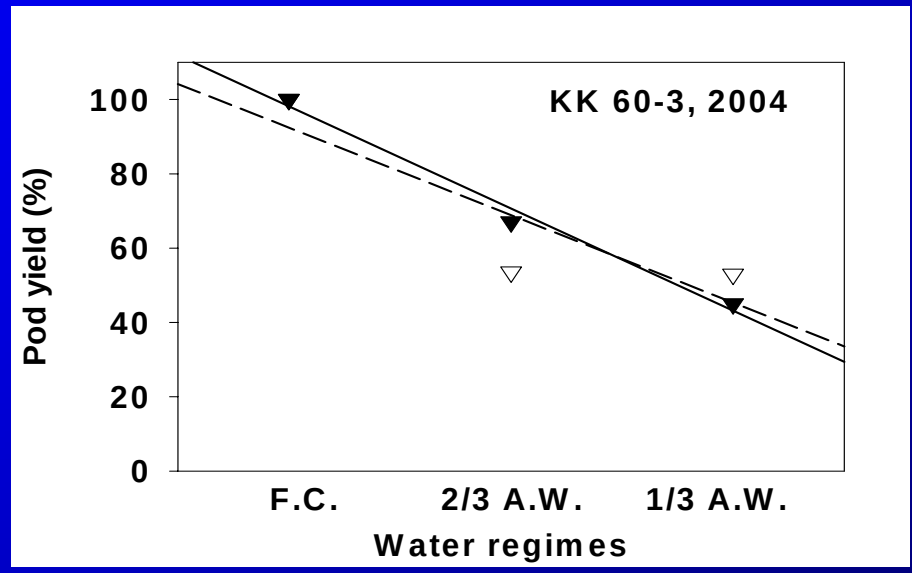


Fig. 2 : Obs. and Sim. total biomass of the three peanut cultivars grown under three soil moisture regimes, expressed as percentages of their corresponding total biomass at Field Capacity (F.C.)





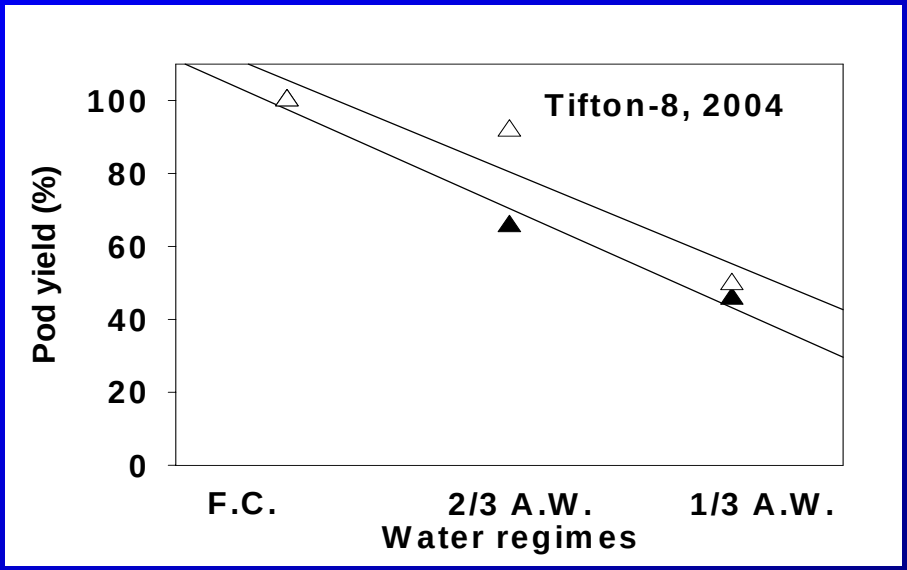
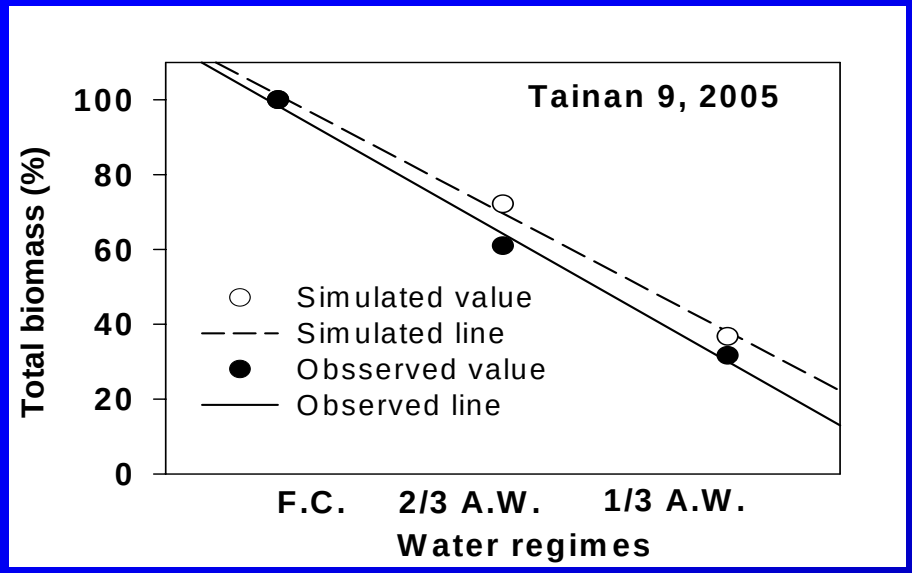
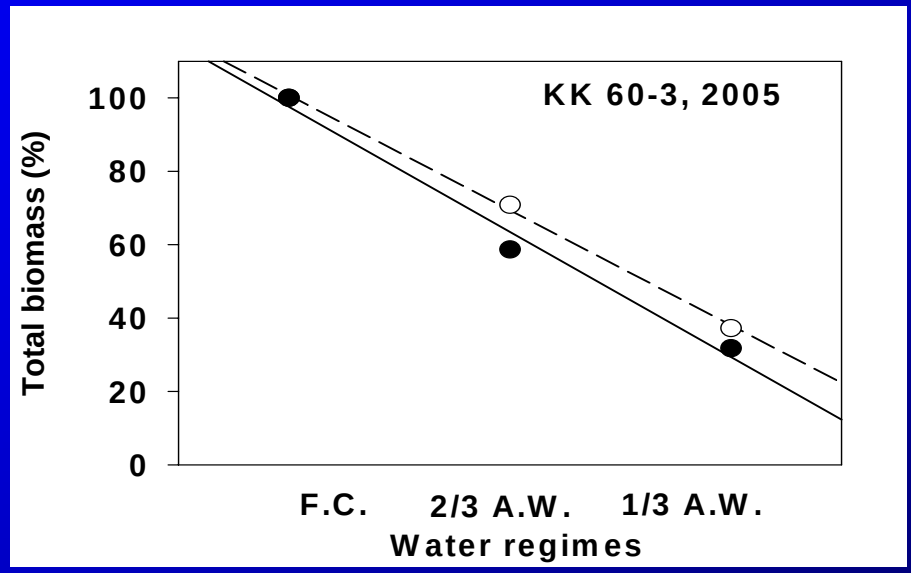


Fig. 3 : Obs. and Sim. pod yield of the three peanut cultivars grown under three soil moisture regimes, expressed as percentages of their corresponding total biomass at Field Capacity (F.C.)





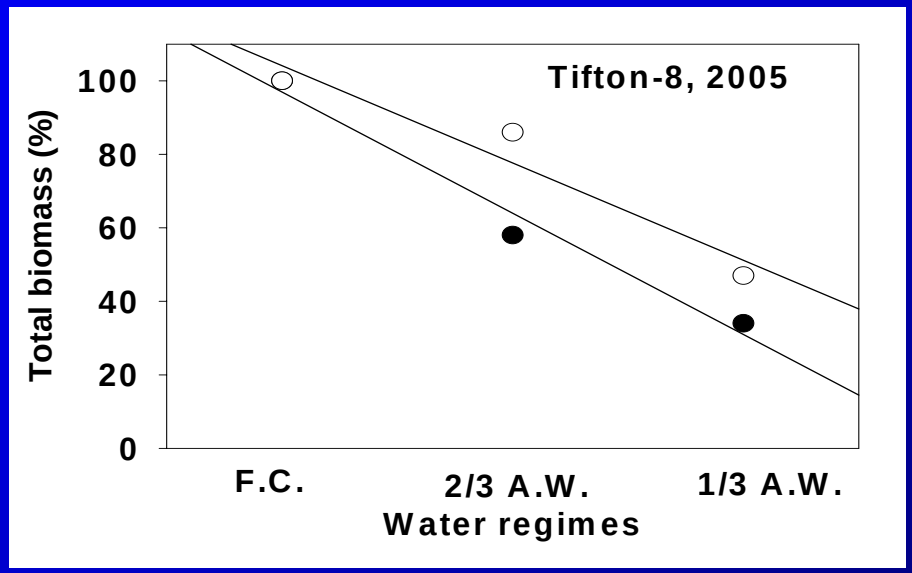
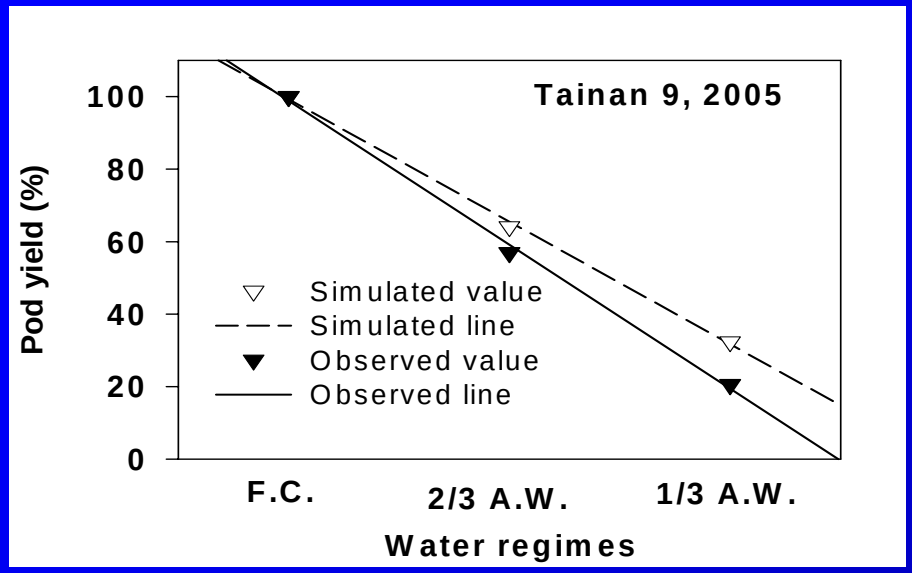
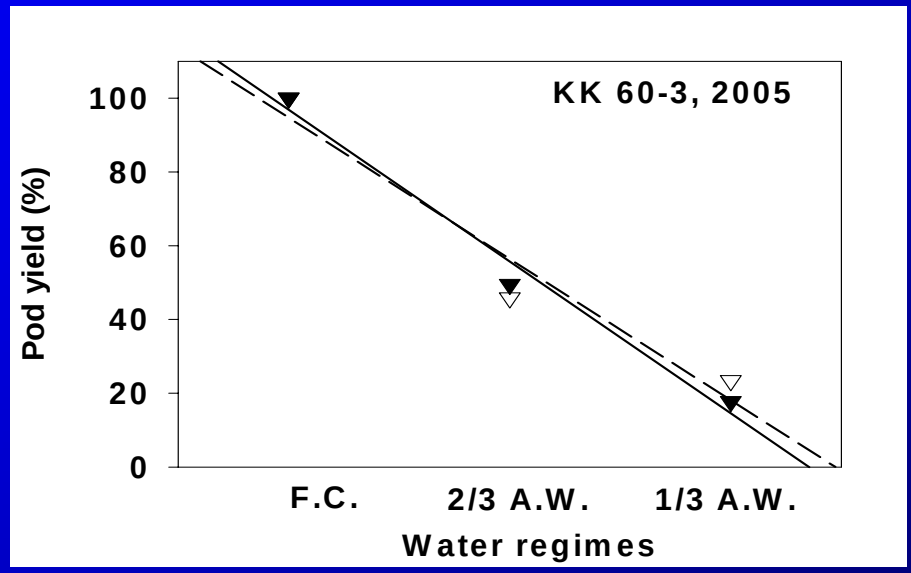


Fig. 4 : Obs. and Sim. total biomass of the three peanut cultivars grown under three soil moisture regimes, expressed as percentages of their corresponding total biomass at Field Capacity (F.C.)





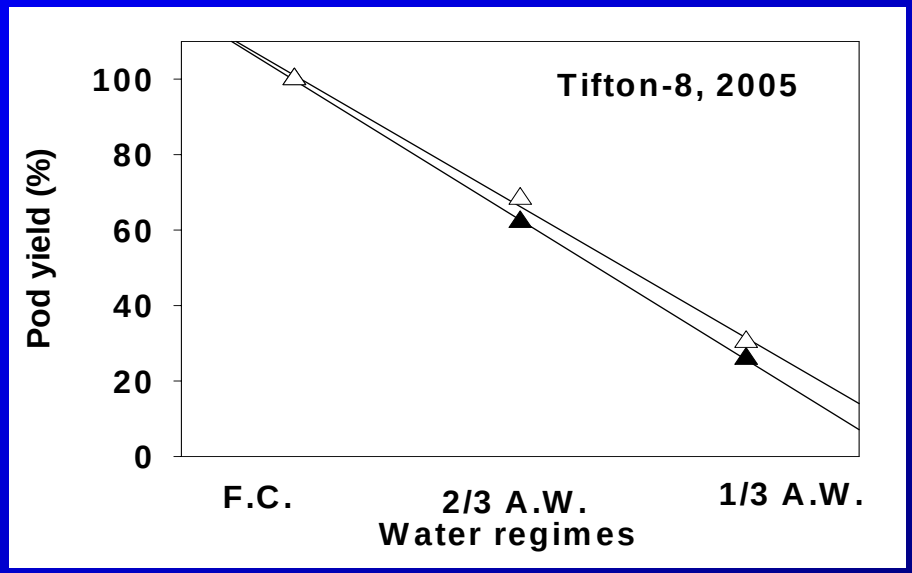


Fig. 5 : Obs. and Sim. pod yield of the three peanut cultivars grown under three soil moisture regimes, expressed as percentages of their corresponding total biomass at Field Capacity (F.C.)

Conclusion

- **The results indicated that the CSM-CROPGRO-Peanut model performed fairly in simulating phenological development and patterns of dry matter accumulation.**
- **The model could simulate the relative pod yield and biomass reduction from drought stress of the individual peanut cultivar quite well.**
- **It was concluded that the CSM-CROPGRO-Peanut model could be used to simulate change in response of peanut caused by different levels of water availability.**

Acknowledgements

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THANK YOU

- The three water-regime treatments were imposed to the individual main-plots by applying different amounts of irrigation water to the plots corresponding to the designated water regimes, starting at 14 days after emergence

- The amount of water applied to a plot to maintain a specified level was determined from water requirement of the peanut crop, calculated following the procedure of Doorenbos and Pruitt (1992).

- Surface evaporation, calculated using the procedure of Singh and Russel (1980).

- Soil moisture of each moisture-regime treatment was also monitored by neutron probes.