CHAPTER - 9: BIBLIOGRAPHY

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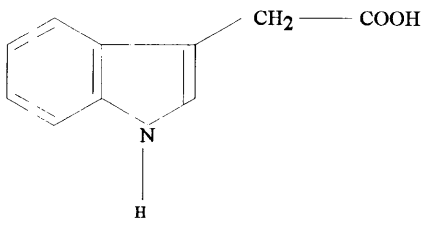
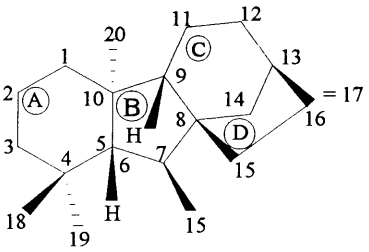
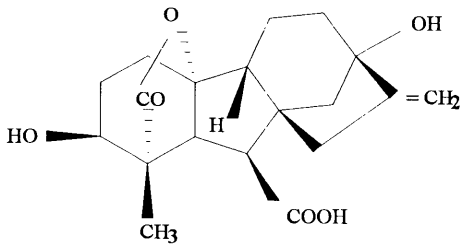
Appendix I: Chem cal structures of the plant hormones.



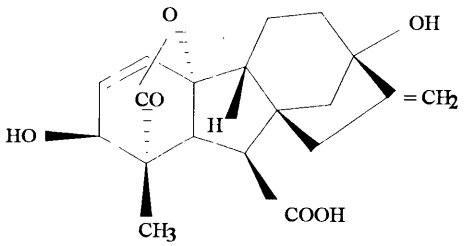
Indole acetic acid.



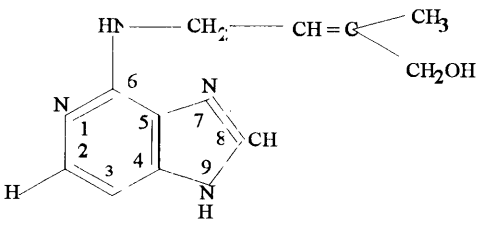
ent-gibberellane skeleton



Gibberellin A_1 (GA_1)



Gibbere lic acid (GA_3)



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Appendix II: Physical and chemical properties of the tested growth retardants.

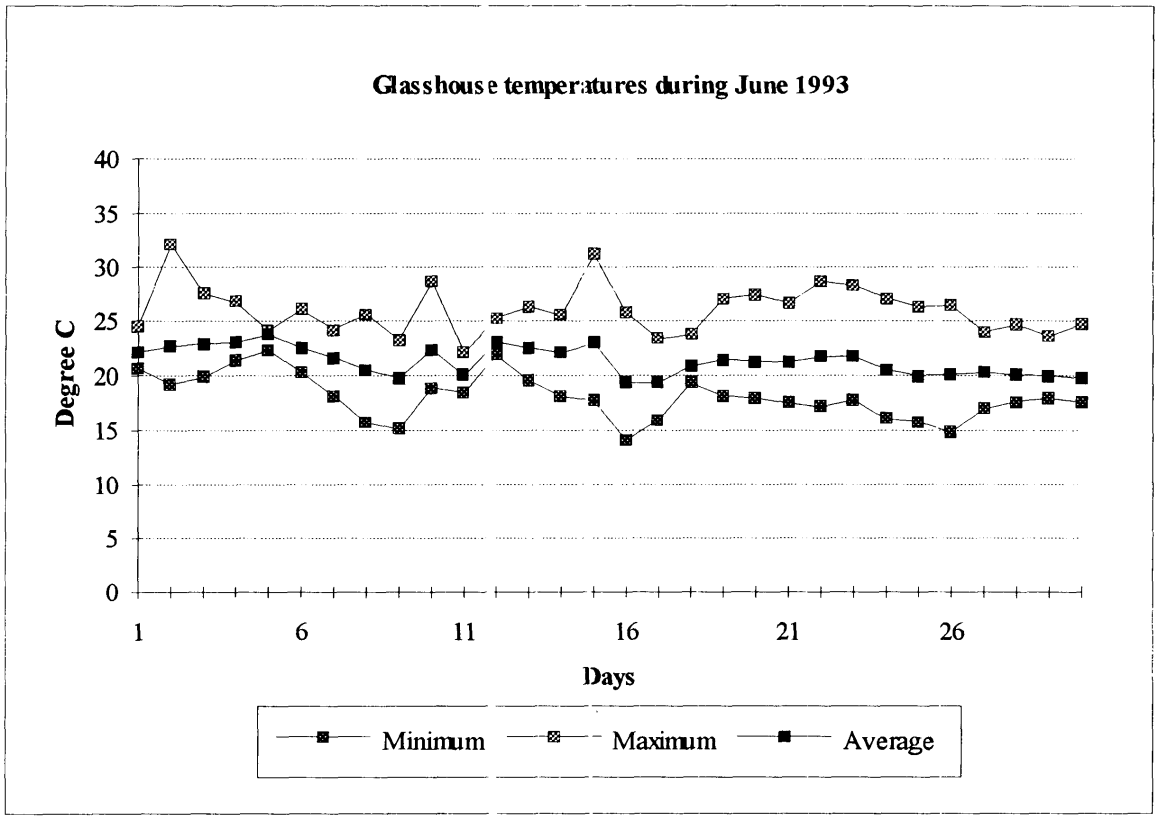
Properties	Ancymidol	Chlormequat Chloride	Daminozide	Flurprimidol	Paclobutrazol
Chemical Formula	α-Cyclopropyl-α-(4-methoxyphenyl)-5-pyrimidinemethanol	2-Chloroethyltrimethylammonium Chloride; (2-chloroethyl)trimethylammonium chloride	Butanedioic acid mono(2,2-dimethylhydrazide)	α-(1-Methylethyl)-α-[4-(trifluoromethoxy)phenyl]-5-pyrimidinemethanol	(R*,R*)-(±)-β-[(4-Chlorophenyl)methyl]-α-(1,1-dimethylethyl)-1H-1,2,4-triazole-1-ethanol
Trade Names	EL-531; A-Rest; Reducymol	CCC; Cycocel Cycogar	B-9; B-995; Alar; B-Nine; Kylar	EL 500; Cutless	PP 333; Bonzi; Clipper; Cultar; Parlay
Molecular Formula	$C_{15}H_{16}N_2O_2$	$C_5H_{13}Cl_2N$	$C_6H_{12}N_2O_3$	$C_{15}H_{15}F_3N_2O_2$	$C_{15}H_{20}ClN_3O$
Molecular Weight	256.31	158.07	160.17	312.29	293.80
Physical State	Crystal Solid	White Crystal Solid	Crystals	Non - volatile white crystals	White Crystalline Solid
Melting Point	110-111°C	at 245°C it decomposes	154-155°C	94-96°C	165-166°C
Solubility	Water at 25°:~ 650 mg/L, Freely soluble in acetone, methanol, ethyl acetate, chloroform, acetonitrile. Moderately in aromatic hydrocarbons; slightly in saturated hydrocarbons	In water & lower alcohols	10% in water, 2.5% in acetone, 5% in methanol	In acetone, ethanol, methanol, dimethylsulfoxide, diethyl ether	Water 35 mg/L, methanol 15%, propylene glycol 5%, acetone 11%, cyclohexanone 18%, methylene dichloride 10%, hexane 1%, xylene 6%
Toxicity	LD_{50} orally in rats 4500 mg/kg	LD_{50} orally in mice 5[illegible] mg/kg	LD_{50} orally (rat) 6810 mg/kg, dermal LD_{50} (rabbit) 10,000 mg/kg***	LD_0 orally in rats >500 mg/kg; LD_{50} dermally in rabbits > 2000 mg/kg	LD_{50} acute and dermal values to the rat approx. 1.50 & 1.00/kg respectively**

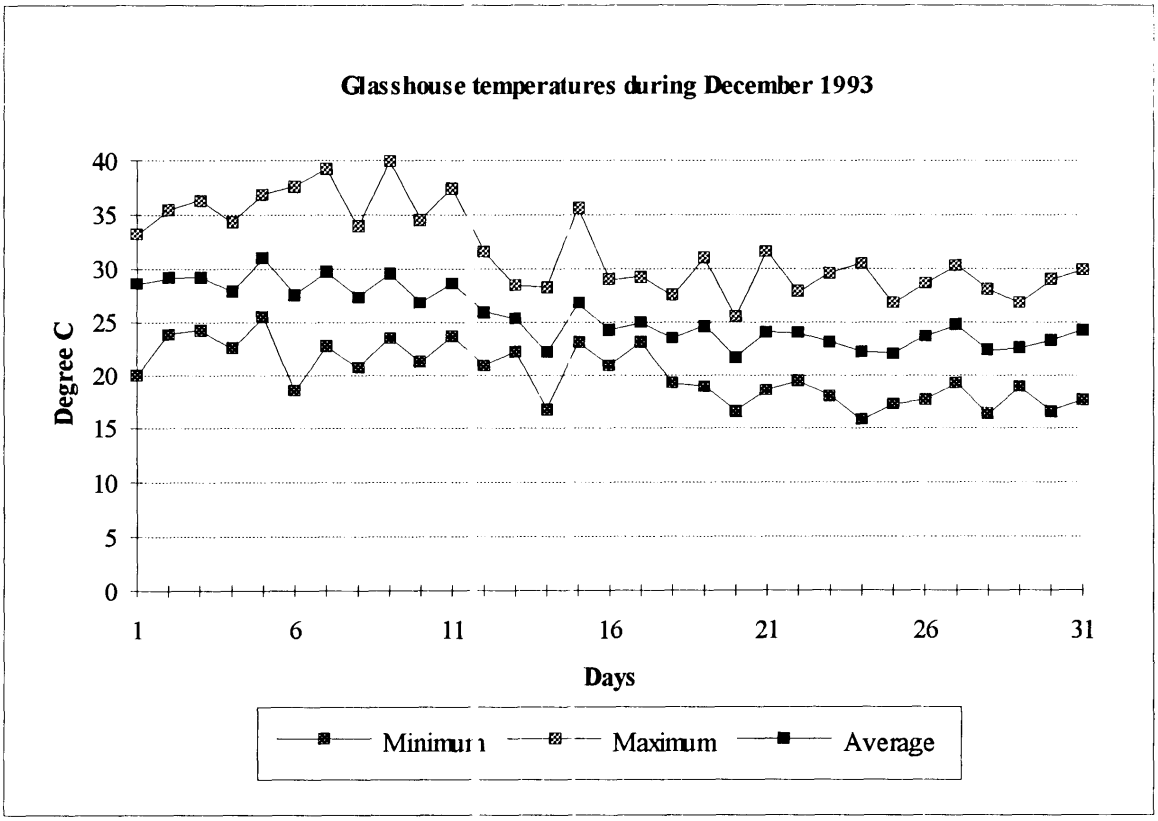
Sources : Budavari, 1989.

** Yau, 1988.

*** ICI personal communication.

Appendix III: Representative glasshouse temperatures in Armidale during 1993.





Appendix IV: Preparation of solutions.

PGRs were mixed with de-ionised distilled (DD) water to make the required volume to be sprayed and the solutions were agitated before and during spraying. The following procedures were used for preparing sprayable solutions of specific PGRs:

Agral (Agral® 600; contains 600 gm/L a.i. Nonyl phenol ethylene oxide condensate; ICI, Australia): This is a wetting agent and was directly dissolved in the final spray volume of different PGRs solutions @ 5μL/50 mL.

Ancymidol (Sigma Chemical Co. Australia; catalogue #A-9431; 1994): Required amount of ancymidol powder was measured and added under agitation with DD water to make actual volume. To make 1 mg a.i./plant, 1 mg ancymidol powder was dissolved in 50 mL water.

BAP (Sigma Chemical Co. Australia; catalogue #B-9395; 1994): One gram of BAP powder was dissolved in 1000 mL water to obtain 1000ppm stock solution. Required amount of BAP powder was dissolved in 1N HCl and then a few drops of 1N NaOH was added to the solution. Required amount of DD water was then added to the make the required volume.

CCC (Cycocel* 77A - contains 77 gm/L chlormequate chloride; Cyanamide, Australia): Required amount of company supplied liquid was dissolved in DD water to make the actual volume. To make 500 mg a.i./plant, 6.493 mL original chemical was dissolved in water to make 50 mL spray solution.

Daminozide (Alar® - contains 85% a.i.; ICI, Australia): Required amount of daminozide powder was dissolved in DD water slowly with agitation. To make 0.1 % a.i./plant, 59 mg powder was dissolved in 50 mL water.

Flurprimidol (Cutless® TP - contains 99% a.i.; DowElanco, Australia): Required amount of flurprimidol was dissolved in 91% ethyl alcohol and then DD water was added to make the required stock solution. To make 1 mg a.i./plant, 16.68 μL stock solution was dissolved in DD water to make the final spray volume of 50 mL.

GA_3 (Sigma Chemical Co. Australia; catalogue #G-7654; 1994): One gm of GA_3 powder was dissolved in a small quantity of 70% ethyl alcohol until the powder was dissolved and produced a clear solution and then water was added to that solution to make the volume to 1000 mL, which gave the 1000ppm stock solution.

IAA (Sigma Chemical Co. Australia; catalogue #I-1250; 1994): One gm of IAA powder was dissolved in a small quantity of pure ethyl alcohol and then dissolved in 1000 mL DD water to make 1000ppm stock solution.

L-tryptophan (Sigma Chemical Co. Australia; catalogue #T-0254; 1994) *and D-tryptophan* (Sigma Chemical Co. Australia; catalogue #T-0129; 1994): Required amount was dissolved in DD water. To make 3 mg/kg soil in 1500 gm of soil, 4.5 mg was dissolved in 50 mL DD water.

NAA (Sigma Chemical Co. Australia; catalogue #N-0640; 1994): One gm of NAA powder was dissolved in small amount of 95% ethyl alcohol and then dissolved in 1000 mL DD water to make 1000ppm stock solution.

PBZ (Bonzi™ - contains 4 gm/L a.i.; ICI, Australia): The required amount of liquid PBZ was measured directly from the company supplied material and was dissolved in DD water to make up the actual volume For 10 mg a.i./plant, 2.5 mL of original material was dissolved in water to make 50 mL final spray solution.

ProGibb® (contains 200 gm/kg a.i.; Abbott Laboratories, Australia): Five gm of ProGibb® soluble powder was dissolved in 1000 mL DD water to make 1000ppm stock solution.

ProVide® (contains 2% w/w a.i.; Abbot Laboratories, USA): Fifty mL of ProVide® clear liquid was added with 950 mL DD water to make 1000ppm stock solution.

Appendix V: Interaction of PBZ and flurprimidol on SDP shoot growth (at 2, 4 and 8 weeks) and at flowering.

Figure (a) PBZ and flurprimidol on main shoot growth at 2 weeks

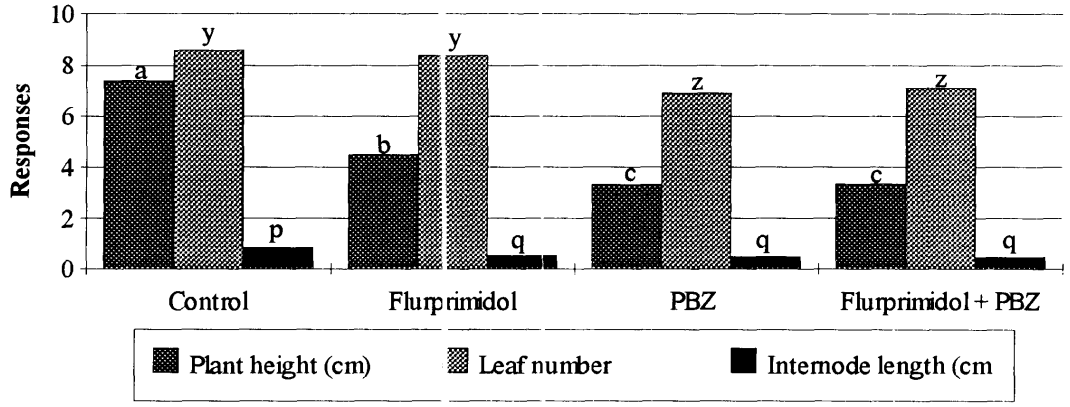


Figure (b) PBZ and flurprimidol on main shoot growth at 4 weeks

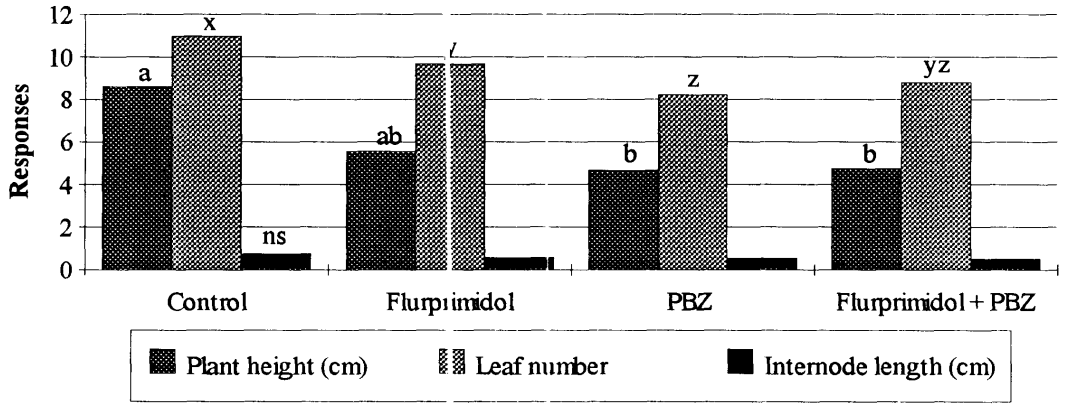


Figure (c) PBZ and flurprimidol on main shoot growth at 8 weeks

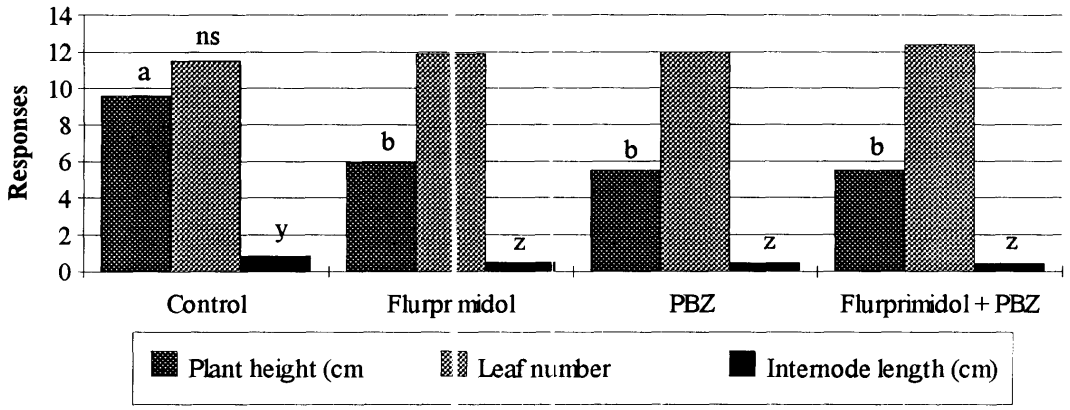


Figure (d) PBZ and f urprimidol on lateral shoot growth at 2 weeks

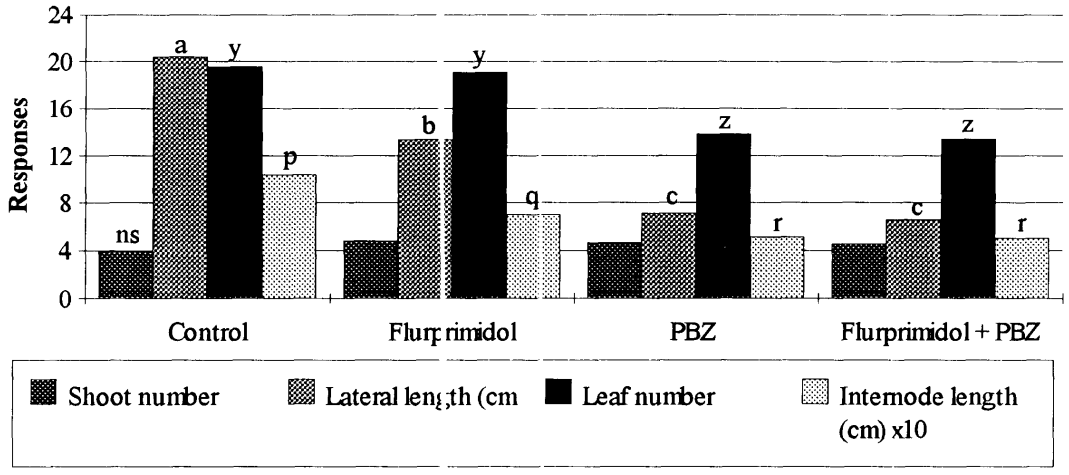


Figure (e) PBZ and flurprimidol on lateral shoot growth at 4 weeks

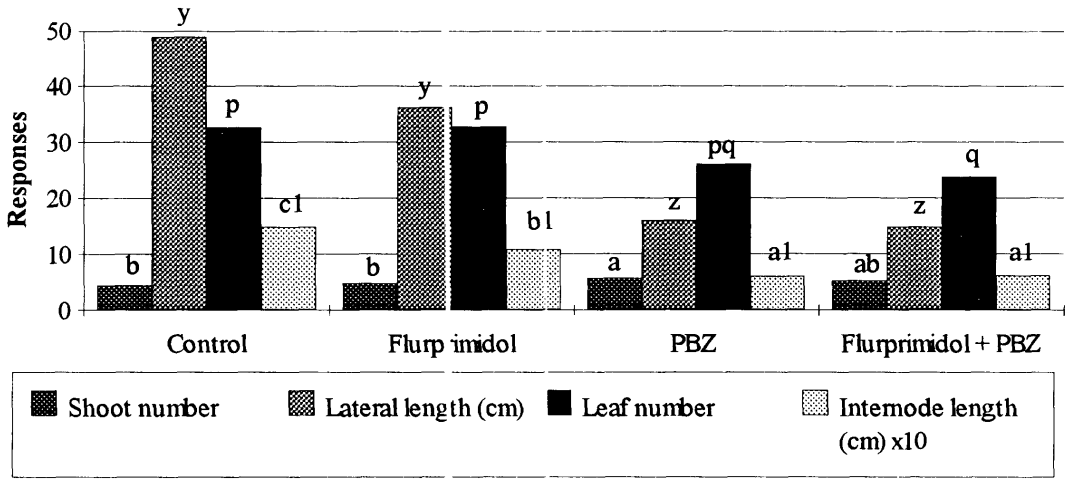


Figure (f) PBZ and flurprimidol on lateral shoot growth at 8 weeks

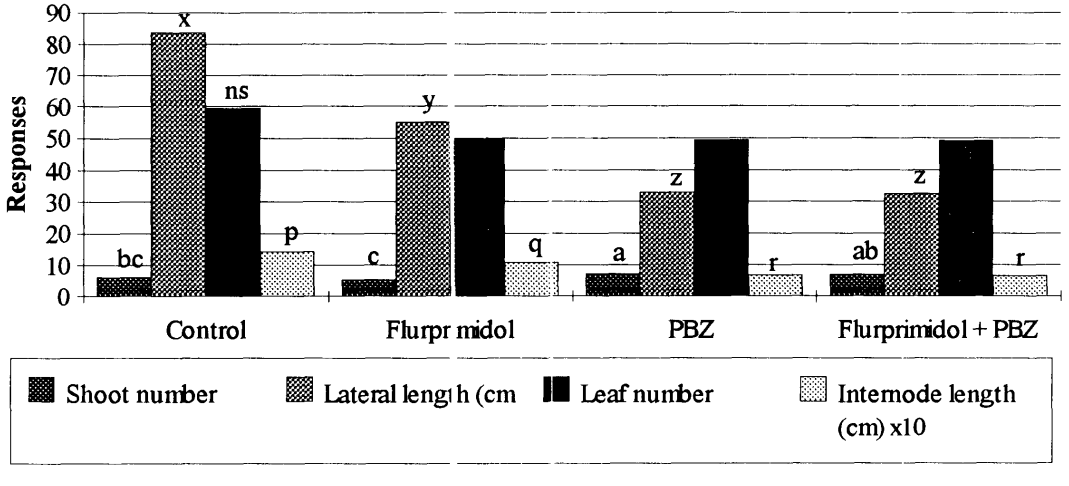
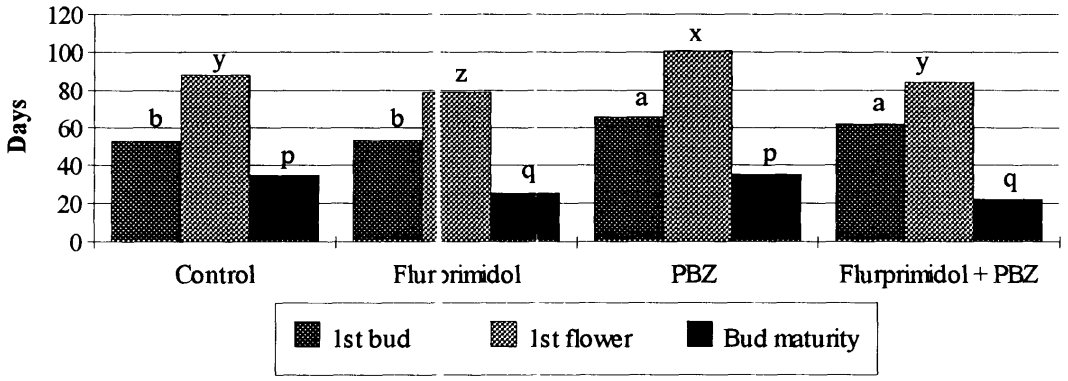


Figure (g) PBZ and flurprimidol on flowering



Appendix VI: Technical limitations to future research.

The use of different seed lots and climatic fluctuations found in an ordinary glasshouse might have contributed to the variations in the responses. For example when plants were grown during winter (Section 4.5, Experiment #1; sown on 11.04.94), the growth retardation by PBZ (10 mg a.i./plant) was about 29% but in summer (Section 4.5, Experiment #2; sown on 23.01.95) it was about 45% of a control plant. However, in the case of growth promotion of plants grown in winter (Section 4.5; Experiment #1; sown on 11.04.94) GA_3 (500ppm) caused a 128% increase in height but when grown in summer (Section 4.3, Experiment #2; sown on 16.02.94) GA_3 caused only an 81% increase. Again the mode of growth reduction by PBZ was variable from experiment to experiment (Section 4.5.4). PBZ reduced internode number (i.e. leaf number) and length in some experiments (Figure 4.2, 4.5 and 4.6) but in other experiments reduced internode length only (Figure 4.18, 4.20 and 4.21) to cause growth retardation.

The use of clonal material could reduce the observed variability within the test plant population. But clonal propagation is limited by the lack of suitable vegetative material and the micro propagation technique is still not used widely (Williams and Taji, 1987). Perhaps, for the time being the use of a uniform seed source and use of a growth cabinet with controlled temperature and light might eliminate some of the observed variability in future experiments.

The inability of the clinostat to negate the effect of gravity could be due to the inappropriate speed of rotation. Further experiments could be done with various speeds of the clinostat to negate the effect of gravity.

Except for the anatomical studies and a few preliminary experiments, 10 replications were used to allow for the variability in the test plant populations. The reduced number of replications for the anatomical data (2 or 3) actually reduced the statistical validity. Increased number of replications could make the data more reliable.

The availability of the instruments and facilities prevented the quantitative testing of hormonal balance in the test plant population. However, measuring hormones is not always possible because of their low concentrations in plant materials, which makes it difficult to isolate and identify them (Goldschmidt, 1976). Another problem is that measuring growth regulator concentrations through tissue extraction destroys compartmentalization of regulators and does not give a true picture. Again at a specific time, low or high concentrations in the tissue may not be expressed as low or high activity (Goldschmidt, 1976). During hormone measurement coexisting inhibitory substances (e.g. ABA or chlorogenic acid) sometimes suppress or mask the activity of the other hormones (e.g. GA_3) in plants (Kojima, 1995). The exact location of hormones should be taken into consideration before measuring them. For example in pea embryo different ABA and GA contents and metabolism compared to the seed coat was noticed (Davies, 1995). The majority of the bioassys do not normally show the real difference between GA_{20} and GA_1; probably those bioassay plants can convert inactive GA_{20} to GA_1 (Davies, 1995).

The interval between the concentrations tested (0.3, 3.0 and 6.0 mg/kg of soil) for L or D-tryptophan were probably too wide. For future experiments the interval between these concentrations could be reduced. If the proper concentration of D-tryptophan is determined, it could also be used to reverse PBZ inhibition of lateral shoot growth along with GA_3.

Other than the use of fewer replications for the anatomical studies (2 or 3) compared to the vegetative data (mostly 10 replications), the anatomical data were also obtained from intact or decapitated plants or from cuttings grown at different times of the year and sampled from different node positions. Contradictory anatomical results were obtained when plants were assessed at 2 different growth stages following PGR application (Section 7.2). The TS data in some experiments had no significant interaction (Section 7.2.3) but significant interaction was found in others (Section 7.3.3 and 7.4.3). These contradictory results need to be taken into consideration before drawing any conclusions.