endosperm, however. is a triploid tissue and this might account for some variability.

The experimental procedure standardized by Nelson[1,2] in maize is simple. The waxy pollen stained red whereas the normal pollen stained blue with iodine–potassium iodide solution. Crosses were made between waxy mutants which produced low frequency of standard normal (WX) type pollen stained blue with varying frequencies. Data from these crosses ultimately allowed detection of mutants with the waxy locus.

In rice, crosses were made between pure breeding (31) *indica* glutinous varieties in all possible combinations, and the blue-staining pollen from F_1 plants were scored. The mutation rate for glutinous to normal was determined by scoring (25 to 75,000) pollen grains in each cross. Pollen from glutinous varieties exhibited red staining with iodine–potassium iodide, while some stained blue. The frequency of 'blue-stained', studied separately for the glutinous varieties, varied from zero to 12.5×10^{-5}. The frequency of 'blue-stained' in each cross over and above the mutation frequency was taken as the frequency of recombinants.

In the cross MNP-263 × MNP-407, the frequency of normal pollen in F_1 was 13.5×10^{-5}, significantly higher than that in the parents (1.64×10^{-5} in MNP-263; 3.8×10^{-5} in MNP-407). This suggests that within the region of the waxy locus, which affects pollen stainability, there are more than one site. Earlier studies[3] with different *indica* varieties suggested the presence of five sites.

The method is useful in the analysis of the fine structure of the glutinous locus. The variation in the synthesis of amylose in glutinous varieties could be exploited through proper breeding programmes to develop lines with desirable quality for various purposes.

6 August 1988; Revised 30 November 1988

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EARLY-MATURING MUTANTS IN GROUNDNUT CULTIVAR PHULE-PRAGATI (JL-24)

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EARLY-maturing groundnut (*Arachis hypogaea* L.) varieties are important for rain-fed cultivation, specially in those locations where the rainfall is limited to a short period of three months or less. More than 75% of the groundnut area in India has this type of agroclimate. Groundnut cultivar Phule–Pragati commonly known as JL-24, is suitable for such areas and is also used as a national check in yield trials of All-India Co-ordinated Projects on Oilseeds[1]. It matures between 90 and 110 days in different agroclimatic zones. Therefore it is desirable to develop cultures maturing in 90 days or less, with yield potential similar to JL-24, and with other useful agronomical attributes. Gamma-ray treatment of JL-24 and screening of M_2 and succeeding populations led to the identification of mutations affecting maturity, seed size, shelling percentage and oil content[2]. Three mutants, viz. JL-24M-6, JL-24M-

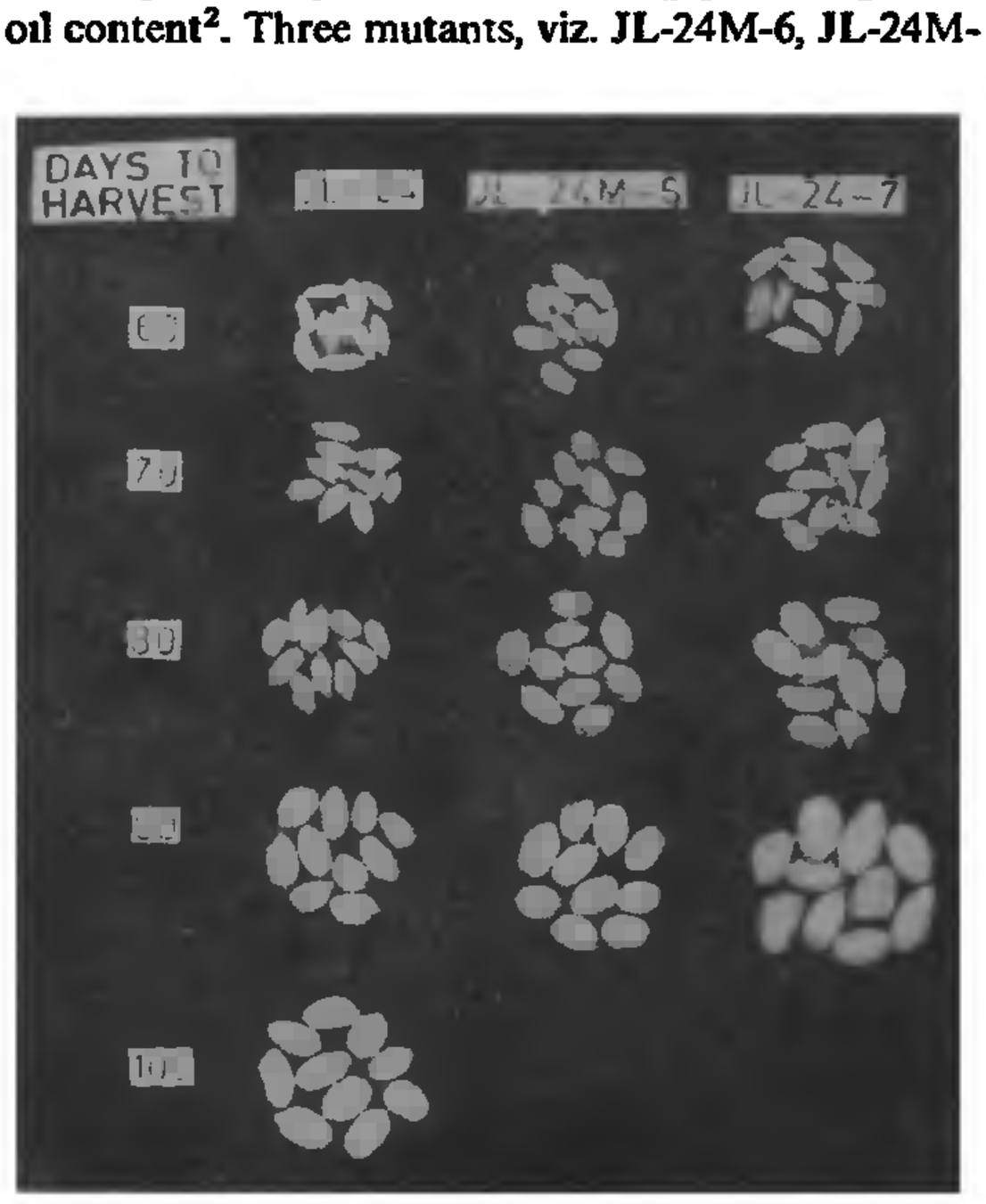

Figure 1. Seed development in the mutants and in JL-24 harvested at 60, 70, 80, 90 and 100 days after sowing.

7 and JL-24M-8, matured in 85–90 days. JL-24M-6 and JL-24M-7 were found to be true-breeding in M_4 and JL-24M-8 stabilized in M_7.

A comparison of the characteristics of the parent and the mutant (tables 1 and 2) showed that, besides early maturity, JL-24M-7 had larger seeds than JL-24. In JL-24M-6 and JL-24M-8 leaflets and seed size were reduced.

Harvest of five random plants at regular intervals from 60 to 110 days of sowing confirmed the early maturity of the mutants at 90 days (table 2) with good seed development, improved shelling percentage and seed size (figure 1).

In yield trials conducted (1987–88) at Trombay

Table 1 *Characteristics of JL-24 and the early-maturing mutants*

Feature	JL-24	JL-24M-6	JL-24M-7	JL-24M-8	CD at 5%
Plant height (cm)	75.5 ± 3.3	51.8 ± 2.1	58.9 ± 4.5	53.5 ± 3.0	
Branches					
primary + secondary	6 + 7	5 + 5	5 + 7	5 + 7	
Leaflet size (cm)					
Length × breadth	8.7 × 4.4	7.6 × 3.8	7.9 × 3.7	7.3 × 4.1	
Days to flower	26	21	22	20	
Days to maturity	100–110	85–90	85–90	85–90	
Number of pods					
(1 + 2 + 3 seeded)	4 + 28 + 4	3 + 45 + 2	5 + 36 + 1	3 + 32 + 1	
Pod yield (kg/ha)					
At 90 days (*kharif*)	2417	2669*	2579*	2526	121
(summer)	1299	1666*	1833*	1644*	285
At 110 days (*kharif*)	2619	2549	2600	2538	166
(summer)	1426	1624	1797*	1609	263
Yield per day (kg/ha)					
At 90 days (*kharif*)	26.86	29.65*	28.66*	28.10	1.3
(summer)	14.43	18.51*	20.36*	18.26*	3.1
At 110 days (*kharif*)	24.35	23.17	23.63	23.07	1.5
(summer)	12.96	14.76	16.33*	14.62	2.3

*Significant superiority over JL-24 at 5%.

Table 2 *Maturity studies in JL-24 and its mutants*

Per plant	Days to harvest	JL-24	JL-24M-6	JL-24M-7	JL-24M-8	CD 1%	CD 5%
Pod yield (g)	60	1.00	3.20**	3.60**	2.58**	0.65	0.47
Seed wt (g)		0.22	1.91**	1.67**	0.98**	0.38	0.27
Shelling percentage		20.00	55.26**	52.26**	38.00**	4.84	3.45
100-seed wt (g)		0.54	3.54**	3.23**	2.25**	0.63	0.43
Pod yield (g)	70	10.08	18.20**	18.80**	13.20**	5.69	4.06
Seed wt (g)		4.50	10.90**	12.30**	7.40**	5.14	3.67
Shelling percentage		44.68	58.42*	64.44**	55.68*	14.49	10.34
100-seed wt (g)		12.70	17.32	22.80**	17.18	9.04	6.45
Pod yield (g)	80	10.40	21.70**	22.40**	20.20**	6.73	4.80
Seed wt (g)		5.30	14.30**	14 50**	13.78**	3.58	2.55
Shelling percentage		51.02	66.18**	67.86**	65.60**	7.46	5.32
100-seed wt (g)		14.82	22.94*	34.18**	22.10*	9.60	6.85
Pod yield (g)	90	19.90	30.70**	32.70**	29.40*	10.60	7.56
Seed wt (g)		12.40	22.60**	23.80**	22.13**	7.78	5.55
Shelling percentage		62.30	73.34**	73.50**	75.28**	3.99	2.85
100-seed wt (g)		24.00	35.04**	50.44**	26.92	9.07	6.47
Pod yield (g)	110	29.00	29.70	32.20	29.40	9.60	6.56
Seed wt (g)		21.25	23.20	23.40	23.23	7.28	5.25
Shelling percentage		73.30	74.64	75.20	74.98	4.29	2.65
100-seed wt (g)		49.00	35.24	5[illegible].24	25.86	10.47	6.21

* and ** significant superiority over JL-24 at 5% and 1% respectively.

the mutants showed higher pod yield compared to JL-24 at 90 days. However, when harvested at 110 days yields were similar (table 1). This indicated that all three mutants matured earlier and had similar yield potential as the parent. Calculated yield per day was also more in the mutants at 90 days. The new cultures are under multilocation testing.

22 September 1988

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IN VITRO PLANT REGENERATION POTENTIAL FROM CALLUS CULTURES OF GRAIN SORGHUM

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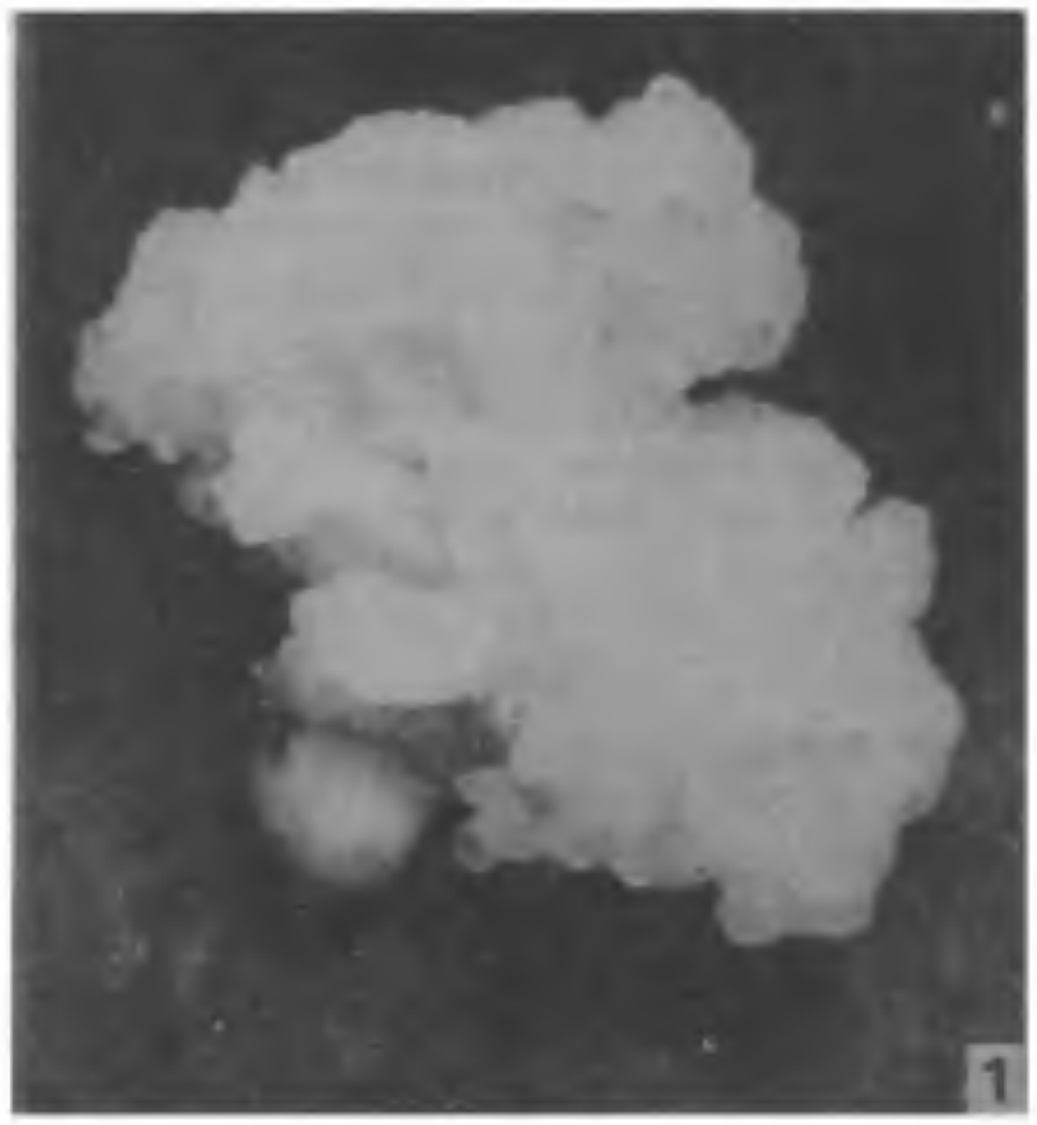
A number of studies on sorghum tissue culture from immature explants have been conducted but without any consistency in embryogenic callus production or high per cent frequency of whole plant regeneration[1,2]. To obtain immature explants, plants should be grown continuously in a greenhouse which is space- and labour-consuming. An attempt was therefore made in the present investigation to induce whole plant regeneration from mature seed callus of three cultivars of grain sorghum.

Seeds of *Sorghum bicolor* (L.) Moench cultivars IS 18417, IS 1054 and IS 18758 were sterilized with 0.1% mercuric chloride for 12 min and then thoroughly washed with sterile distilled water (3–4 times). One or two seeds were inoculated into Linsmaier and Skoog's (LS) medium[3] containing either 2 mg/l of 2,4-dichlorophenoxyacetic acid (2,4-D), or 2 mg/l of 2,4,5-trichlorophenoxyacetic acid (2,4,5-T), or 2 mg/l 2,4-D + 0.5 mg/l 2,4,5-T, or 2 mg/l 2,4-D + 1 mg/l 2,4,5-T. Fifteen ml of medium was taken in each culture tube and autoclaved at 1.2 kg/cm^2 at 120°C for 15 min. The cultures were incubated under continuous fluorescent light (1000 lux at 25 ± 2°C) for callus proliferation. After 15 days, the calli were transferred to Murashige and Skoog's (MS) medium[4] supplemented with 2.5 mg/l of 2,4-D. The cultures were maintained on this medium for 6 subcultures at 15-day intervals. For development of shoots and roots, callus (150 ± 15 mg) was transferred into MS medium containing different



Figures 1 and 2. 1, Callus from seed of IS 1054 on LS medium containing 2 mg/l 2,4-D and 2% sucrose; 2, Regenerated plantlet from callus culture of IS 1054 on MS medium supplemented with 5 mg/l BAP, 1 mg/l 2,4-D and 3% sucrose.