

EFFECT OF PACKING MATERIAL AND MOISTURE CONTENT ON THE VIABILITY OF SEED PADDY

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ABSTRACT

Effect of packing material (polythene, pricked polythene, polysack and gunny) and moisture content (12% and 14%) on the viability of seed paddy was studied. Two rice varieties; Bw 78 and Bg 400—1 were used in the study.

Three way interaction effect of packing material \times moisture content \times time of storage and the two way interaction effects of packing material \times moisture content, packing material \times time of storage and variety \times time of storage were found to be significant

If gunny was used as the packing material in storage, 2½ months old seed with 95% viability at packing could retain not less than 80% of its viability for a period of about 21 weeks despite the moisture content (12% and 14%) of seed at packing. If seed paddy was packed in polythene and polysack, the moisture content of seed at packing was the critical factor on which the time of storage was dependent with regard to seed viability. Higher the moisture content of seed at packing higher the rapidity of viability loss and shorter the time of storage of seed paddy in polythene. This appeared to be other way round in polysack. This behaviour of polysack is subject to confirmation by further investigations. Seed 2½ months old and 95% viable seed with 12% and 14% moisture at packing in polythene could retain not less than 80% of its viability for a period of about 27 and 12 weeks respectively. Thus it is evident that packing seed with 12% moisture in polythene will enable the seed to be used as seed paddy even after one season of storage without any risk.

INTRODUCTION

During the last few years, rice farmers in the low-country wet zone increasingly complained about rapid loss of seed viability in storage. This, accordingly was attributed to the type of packing materials, in common use today. Gunny bags, (made from jute fibers) which were

commonly used for seed paddy storage have been replaced gradually by polythene and polysack bags. Therefore it is important to investigate the effect of packing material on viability of seed paddy in storage.

In addition to the general conditions of the seed paddy at storage, seed viability is known to be preserved under low temperature, humidity and moisture conditions. Adair (1966) and Ito (1975) also reported the necessity of low temperature and low moisture in seed in long term storage of rice. Manjula Biswas and S. M. Sircar (1976) reported the threshold level of moisture to be 8% in rice seed for viability. Nishiyama (1977) found that rice seeds of 10–14% moisture content can be stored in good conditions at 18°C for more than two years. Md. Zohurul Haque and Mahmuda (1983) pointed out that when rice seed with 12% moisture was stored in baby food containers and gunny bags, seed viability remained high upto 352 days and not more than 180 days from harvest, respectively. However, very little work has been done on the locally available packing materials and their effect on viability of seed paddy packed in them at different moisture levels. This is of wide practical importance to the local farmers and others who need to keep seed paddy viable for a longer period of time. The following experiments were therefore conducted to study the effect of the packing materials which are in common use and the moisture content of seed paddy at packing on the viability. This study therefore expected to highlight an effective storage method for seed paddy under farmers' conditions.

MATERIALS AND METHOD

Seed materials of two rice varieties, Bg 400 - 1 and Bw 78, and four types of packing materials, Polythene, Pricked polythene, Polysack, and Gunny, and two moisture contents of seed; 14% and 12%, were used in the experiment. Pricked polythene was made by making a prick in each cm² of polythene with a heated thin stem half-inch iron nail. Guage of the polythene used in the experiment was 300. Treatments of packing materials and moisture contents were imposed on varieties in a factorial arrangement so that 16 treatment combinations were obtained. The treatment combinations were laid out in a completely randomized design with 2 replications. The seed paddy of two varieties were tested for their germination and packed in different packing materials. Weight of the seed in each bag that represented each replicate of each treatment combination was 1 kg. A bag of this weight was assumed to be shown the treatment effect during storage.

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Each treatment combination was tested for its effect on germination of seed with the use of rag-doll method at 3 week intervals. The germination tests were based on two 100 grain samples from each bag. Thus the average germination percentage of these two samples was considered to be the representative measurement of the seed viability in each bag. The bags were opened slightly with care and grains in each sample and the two separate samples from each bag were taken randomly. Following sampling, openings of the bags were sealed immediately. Germination test was continued until the germination percentages were very low so that 11 repeated observations or tests (3 wks., 6 wks., 33 wks.) were taken from each of the 16 treatment combinations of variety \times packing material \times moisture content. Hence the whole experiment was considered to be in a split plot design where the 16 treatment combinations of variety \times packing material \times moisture content were considered as main plots laid out in a completely randomized manner while the 11 repeated observations or tests that represent the time of storage were considered as sub-plots.

All the bags of seed paddy were stored in a normal paddy storing room without any chemical control of seed paddy pests because it was assumed that the chemicals might interfere with the treatment effects on seed viability. Thus only the grains which were free from pest damage were tested for germination in order to remove any variations that might have been imposed due to pest attacks on seed viability.

Data obtained were analysed statistically using arcsine transformation. In the case where interaction effects were found to be significant, they were further examined using response curves plotted with original data.

RESULTS AND DISCUSSION

Germination percentages of the varieties in all types of packing material at all moisture contents at all times of storage are presented in table 1. The seed paddy of both varieties had been stored in gunny bags for a period of about $2\frac{1}{2}$ months before the commencement of the experiment. Moreover, no unpredictable variation was created on seed viability due to storage pests since only the grains which were free from pest damage were tested for germination.

While the four way interaction effect of variety \times packing material \times moisture content \times time of storage was found to be not significant, the packing material \times moisture content \times time of storage was the only three way interaction effect that was found to be significant. Two way interaction effects of packing material \times moisture content, packing material \times time of storage, moisture content \times time of storage and variety \times time of storage were also found to be significant. Separate analysis of variance at each test showed that the interaction effect of packing material \times moisture content was not significant at 3, 6 and 9 weeks of storage but significant at all the times of storage from 12—33 weeks.

Interaction effect of gunny vs pricked polythene \times moisture content was found to be not significant and the average effects of gunny and pricked polythene were also found to be not significantly different at 5% probability level. These results suggested the validity of generalization of the reduction of seed viability with the time of storage over gunny and pricked polythene despite the variety and the seed moisture content at packing. Since moisture could exchange through gunny and pricked polythene with tiny holes on the material, any content of moisture (within a narrow range) in the seed at the time of packing would give the same effect over the time of storage regardless of the packing material itself and the variety. This is because seed with a given content of moisture would either absorb moisture from the surrounding atmosphere or release its excess moisture to its surrounding atmosphere through the material until different moisture contents attain a similar equilibrium moisture content is attained, depending on the relative humidity in the store room. The mean relative humidity and the mean temperature in the store room during the course of the experiment are presented in Fig. 1.

The response curve showing the change of germination percentage of seed with the time, averaged over gunny and pricked polythene despite the variety and the seed moisture content is also presented in Fig. 1. Germination of seed decreased with the time of storage in a sigmoid pattern. Seed viability could be maintained above 80% only for a period of about 21 weeks from the date of packing when 2½ months old seed was packed in gunny or in pricked polythene.

When seed paddy was packed in polythene the reduction of germination with the time of storage varied with the moisture content of seed at packing (Fig. 2). If the moisture content of seed at packing was 14%, the reduction

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of the germination with the time of storage varied in the sigmoid pattern. Thus seed viability at the higher content of seed moisture in polythene could be maintained above 80 % only for a period of about 12 weeks from the date of packing when the age of the seed at packing was about 2½ months. This contrasted the condition where the seed viability could be maintained above 80 % for a period of about 27 weeks if 2½ months old seed with 12 % moisture was packed in polythene. Therefore it is evident that packing seed with 12 % moisture in polythene will enable the seed to be stored over a season in good quality without any risk. The seed with different contents of moisture when packed in polythene started to react differently to different times of storage only after 9 weeks of storage. Rate of moisture exchange through polythene appeared to be exceptionally lower than that of gunny or pricked polythene. This is the reason why the different contents of seed moisture gave different effects on seed viability through the time scale when seed was packed in polythene.

Unlike in polythene, gunny, and pricked polythene reduction of the germination of seed with the time behaved entirely in a different way in polysack such that the germination of seed with 14 % moisture was significantly higher than that of seed with 12 % moisture during the period from 21 to 30 weeks of storage (Fig. 3). At 24th week of storage, the seed with high moisture (14%) showed a germination above 80 % while the seed with low moisture (12%) showed a germination about 63 % implying the suitability of polysack in maintaining viability of seed with 14 % moisture at packing even at 24 weeks of storage. However, this superiority of seed viability at high moisture in polysack initiated at 12 weeks of storage only became significant at 24 weeks of storage. Both contents of seed moisture showed a germination of very much less than 80 % at 27th week after packing and onward while germination at high moisture continued to be superior to that of low moisture from 27 to 30 weeks of storage. Explanation for this behaviour of polysack is beyond the present study. However, further investigations should be made in order to make firm conclusions on this matter.

CONCLUSIONS

Regarding the retention of good viability of seed paddy for a longer period of time in storage, moisture content of seed at packing should be selected according to the packing material used despite the variety. Higher the moisture content of seed at packing, shorter the time of storage that could retain above 80 % of seed viability when seed was packed in polythene. This appeared to be other way round in polysack. This behaviour of polysack is subject to confirmation by further investigations. If seed paddy is packed in gunny, the time of storage that could retain above 80 % of seed viability is no longer dependent upon the moisture content of seed at packing since moisture exchange through gunny is exceptionally high.

REFERENCES

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Table 1. Germination percentages of Bg 400—1 and Bw 78 under all packing materials, at all the moisture contents, and at all the times of storage.

Time of storage (wks)	Germination percentage							
	Polythene				Pricked Polythene			
	L ⁺		H ⁺		L		H	
	V ₁ ⁺⁺	V ₂ ⁺⁺	V ₁	V ₂	V ₁	V ₂	V ₁	V ₂
0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0
3	94.5	95.0	93.5	92.6	87.0	95.0	88.0	95.5
6	95.5	96.0	94.0	96.0	97.0	96.0	95.5	95.5
9	91.5	92.0	86.0	90.5	89.0	91.0	87.0	94.5
12	95.0	92.5	83.0	88.0	87.5	92.0	94.5	94.0
15	96.0	96.0	77.5	78.0	87.0	91.0	89.5	94.5
18	92.5	93.5	66.0	68.0	89.0	92.0	85.0	91.5
21	90.0	92.5	43.0	46.0	90.0	83.0	86.5	86.0
24	85.3	92.0	37.0	26.5	77.0	67.0	87.0	73.5
27	84.0	78.5	8.0	4.0	29.0	25.0	46.0	25.0
30	57.3	62.5	4.5	3.0	12.0	7.0	30.5	6.0
33	33.0	18.0	1.5	1.0	1.5	2.0	1.8	3.0

(Table 1. continued)

Time of storage (wks)	Germination percentage							
	Gunny				Polysack			
	L		H		L		H	
	V ₁	V ₂	V ₁	V ₂	V ₁	V ₂	V ₁	V ₂
0	95.0	95.0	95.0	95.0	95.0	95.0	95.0	95.0
3	95.5	95.0	95.0	88.5	89.5	89.5	91.0	92.0
6	92.0	94.0	91.0	96.0	95.0	95.5	92.0	94.0
9	86.5	91.0	85.5	90.5	91.0	93.0	89.0	91.0
12	91.0	94.0	93.0	92.0	92.0	91.0	89.5	92.0
15	88.5	91.0	94.0	93.0	89.0	84.5	93.0	94.5
18	85.0	86.5	86.0	91.5	87.0	86.5	88.5	88.5
21	83.0	88.0	82.0	87.5	79.5	83.0	83.5	89.0
24	78.5	63.5	63.5	59.0	61.0	65.0	82.5	81.5
27	39.0	19.5	37.0	9.0	24.0	21.0	47.0	31.5
30	18.5	1.5	13.5	5.5	10.0	4.0	22.5	8.5
33	3.8	1.0	4.0	2.0	4.0	1.0	6.5	1.5

+ L = 12% moisture

+ H = 14% moisture

++ V₁ = BG 400—1

++ V₂ = BW 78

(Table 1. continued.)

ANOVA for the whole experiment (Repeated observations or times of storage are taken as sub-plots).

<i>Source of Variation</i>	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>
Subplots	351	199050.16	567.09	
Main plots	31	10948.67	353.18	
Varieties	1	89.60	89.60	3.22
Packing Materials	3	158.82	52.93	1.90
Moisture Content	1	1400.01	1400.01	50.39**
V × PM	3	43.43	14.48	.52
V × M	1	.10	.10	.003
PM × M	3	8797.10	2932.37	105.55**
V × PM × M	3	15.15	5.05	.18
Main plot error	16	444.46	27.78	
Time of storage	10 (1)§	173330.37	173330.37	1192.91**
V × T	10 (1)	1474.47	147.45	10.14**
PM × T	30 (3)	2995.79	99.85	6.87**
M × T	10 (1)	778.50	77.85	5.63**
V × PM × T	30 (3)	824.14	27.47	1.89
V × M × T	10 (1)	177.15	17.72	1.22
PM × M × T	30 (3)	5787.22	192.91	13.27**
V × PM × M × T	30 (3)	408.83	13.63	.93
Subplot error	160(16)	2325.02	14.53	

§ Tabular F values for time of storage, all the interactions that involve time of storage and subplot error are selected on the basis of the degrees of freedom in parentheses. This is a conservative approach recommended by many statisticians when repeated observations are taken as subplots.

** Significant at 1% probability level.

Symbols for treatment factors : V = Variety, PM = Packing Material,
M = Moisture Content, T = Time of storage.

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(Table 1. continued).

Orthogonal partitioning of some selected main effects and interaction effects.

<i>Source of variation</i>	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>
Packing material	3	158.82	52.93	1.90
G vs. B	1	65.37	65.37	2.35
PM × M	3	8797.10	2932.37	105.55**
P vs. B+G+F × M	1	8556.85	8556.85	308.02**
F vs. B+G × M	1	138.99	138.99	5.00*
B vs. G × M	1	101.26	101.26	3.64
Main plot error	16	444.46	27.78	

** Significant at 1% level.

* Significant at 5% level.

Symbols for treatment factor levels : P = Polythene, F = Polysack,
B = Pricked polythene, G = Gunny.

ANOVA for each repeated observation or time of storage.

3 weeks after packing

<i>Source of variation</i>	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>
Total	31	466.75		
Treatment	15	297.14	19.81	1.86
Variety	1	27.01	27.01	2.54
Moisture content	1	14.58	14.58	1.37
Packing material	3	61.37	20.45	1.93
V × M	1	.72	.72	.06
V × PM	3	110.09	36.69	3.46*
PM × M	3	80.09	26.69	2.51
V × PM × M	3	3.26	1.08	.10
Error	16	169.61	10.60	

* Significant at 5% level.

(Table 1. continued).

6 weeks after packing

<i>Source of variation</i>	<i>df</i>	<i>SS</i>	<i>MS</i>	
Total	31	330.01		
Treatment	15	131.70	8.78	.71
Variety	1	25.37	25.37	2.11
Moisture content	1	8.50	8.50	.71
Packing material	3	53.75	17.91	1.44
V × PM	3	22.91	7.63	.61
V × M	1	5.87	5.87	.47
PM × M	3	12.15	4.05	.32
V × PM × M	3	3.11	1.03	.08
Error	16	198.30	12.39	

9 weeks after packing

<i>Source of variation</i>	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>
Total	31	283.04		
Treatment	15	173.81	11.58	1.69
Variety	1	86.46	86.46	12.66**
Moisture content	1	11.05	11.05	1.61
Packing material	3	28.12	9.37	1.37
V × M	1	12.74	12.74	1.86
V × PM	3	6.69	2.23	.32
PM × M	3	17.00	5.66	.83
V × PM × M	3	11.73	3.91	.57
Error	16	109.23	6.82	

** Significant at 1% level.

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(Table 1. continued).

12 weeks after packing

<i>Source of variation</i>	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>
Total	31	409.33		
Treatment	15	247.00	16.46	1.62
Variety	1	10.81	10.81	1.06
Moisture content	1	10.81	10.81	1.06
Packing material	3	20.44	6.81	.67
V × M	1	.49	.49	.04
V × PM	3	4.52	1.50	.14
PM × M	3	150.02	50.00	4.92*
V × PM × M	3	49.88	16.62	1.63
Error	16	162.33	10.14	

*Significant at 5% level.

Standard error for differences between means of the treatment combinations of PM × M = 2.253% (for transformed data).

15 weeks after packing

<i>Source of variation</i>	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>
Total	31	893.86		
Treatment	15	786.64	52.44	7.82**
Variety	1	10.81	10.81	1.61
Packing material	3	37.24	12.41	1.85
Moisture content	1	4.35	4.35	.64
V × PM	3	29.07	9.69	1.44
V × M	1	3.92	3.92	.58
PM × M	3	680.97	226.94	33.87**
PM × M × V	3	20.30	6.76	1.01
Error	16	107.22	6.70	

**Significant at 1% level.

Standard error for differences between means of the treatment combinations of PM × M = 1.83% (for transformed data).

(Table 1. continued).

18 weeks after packing

<i>Source of variation</i>	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>
Total	31	1102.75		
Treatment	15	1035.45	69.03	16.43**
Variety	1	37.91	37.91	9.02**
Moisture content	1	147.02	147.02	35.00**
Packing material	3	178.21	59.40	14.14**
V × M	1	6.85	6.85	1.63
V × PM	3	22.03	7.34	1.74
PM × M	3	634.29	211.4	50.30**
PM × M × V	3	9.14	3.04	.72
Error	16	67.30	4.20	

** Significant at 1% level.

Standard error for differences between means of the treatment combinations of
 PM × M = 1.45% (for transformed data).

21 weeks after packing

<i>Source of variation</i>	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>
Total	31	2747.18		
Treatment	15	2687.84	179.18	48.42**
Variety	1	20.18	20.18	5.45*
Moisture content	1	387.35	387.35	104.68**
Packing material	3	624.06	208.02	56.22**
V × M	1	7.20	7.20	1.94
V × PM	3	68.23	22.74	6.14**
PM × M	3	1569.91	523.30	141.43**
PM × V × M	3	10.91	3.63	.98
Error	16	59.33	3.70	

* Significant at 5% level.

** Significant at 1% level.

Standard error for differences between means of the treatment combinations of
 PM × M = 1.36% (for transformed data).

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(Table 1. continued).

24 weeks after packing

<i>Source of variation</i>	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>
Total	31	4038.02		
Treatment	15	3827.32	255.15	19.38**
Variety	1	94.77	94.77	7.20*
Moisture content	1	307.77	307.77	23.38**
Packing material	3	358.72	119.57	9.08**
V × M	1	16.88	16.88	1.28
V × PM	3	121.38	40.46	3.07
PM × M	3	2833.50	944.50	71.77**
PM × V × M	3	94.30	31.43	2.38
Error	16	210.70	13.16	

* Significant at 5% level.

** Significant at 1% level.

Standard error for differences between means of the treatment combinations of
 PM × M = 2.56% (for transformed data).

27 weeks after packing

<i>Source of variation</i>	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>
Total	31	7516.05		
Treatment	15	6668.69	444.57	8.39**
Variety	1	577.74	577.74	10.90**
Moisture content	1	811.24	811.24	15.31**
Packing material	3	323.69	107.89	2.03
V × M	1	89.24	89.24	1.68
V × PM	3	178.27	59.42	1.12
PM × M	3	4674.62	1558.20	29.42**
PM × V × M	3	13.90	4.63	0.08
Error	16	847.36	52.96	

** Significant at 1% level.

Standard error for differences between means of the treatment combinations of
 PM × M = 5.14% (for transformed data).

(Table 1. continued).

30 weeks after packing

<i>Source of variation</i>	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>
Total	31	5955.76		
Treatment	15	5402.78	360.18	10.42**
Variety	1	560.37	560.37	16.21**
Moisture content	1	339.56	339.56	9.82**
Packing material	3	982.71	327.57	9.47**
V × M	1	12.08	12.08	0.35
V × PM	3	252.63	84.21	2.43
PM × M	3	3088.48	1029.49	30.27**
PM × V × M	3	166.95	55.65	1.61
Error	16	552.98	34.56	

** Significant at 1 % level.

Standard error for differences between means of the treatment combinations of
 PM × M = 4.15 % (for transformed data).

33 weeks after packing

<i>Source of variation</i>	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>
Total	31	2344.42		
Treatment	15	2096.37	139.75	9.01**
Variety	1	155.57	155.57	10.03**
Moisture content	1	177.89	177.89	11.47**
Packing material	3	509.18	169.72	10.94**
V × M	1	13.10	13.10	0.84
V × PM	3	101.70	33.90	2.18
PM × M	3	1109.99	369.99	23.87**
PM × V × M	3	28.99	9.66	0.62
Error	16	248.05	15.50	

** Significant at 1 % level.

Standard error for differences between means of the treatment combinations of
 PM × M = 2.78 % (for transformed data).

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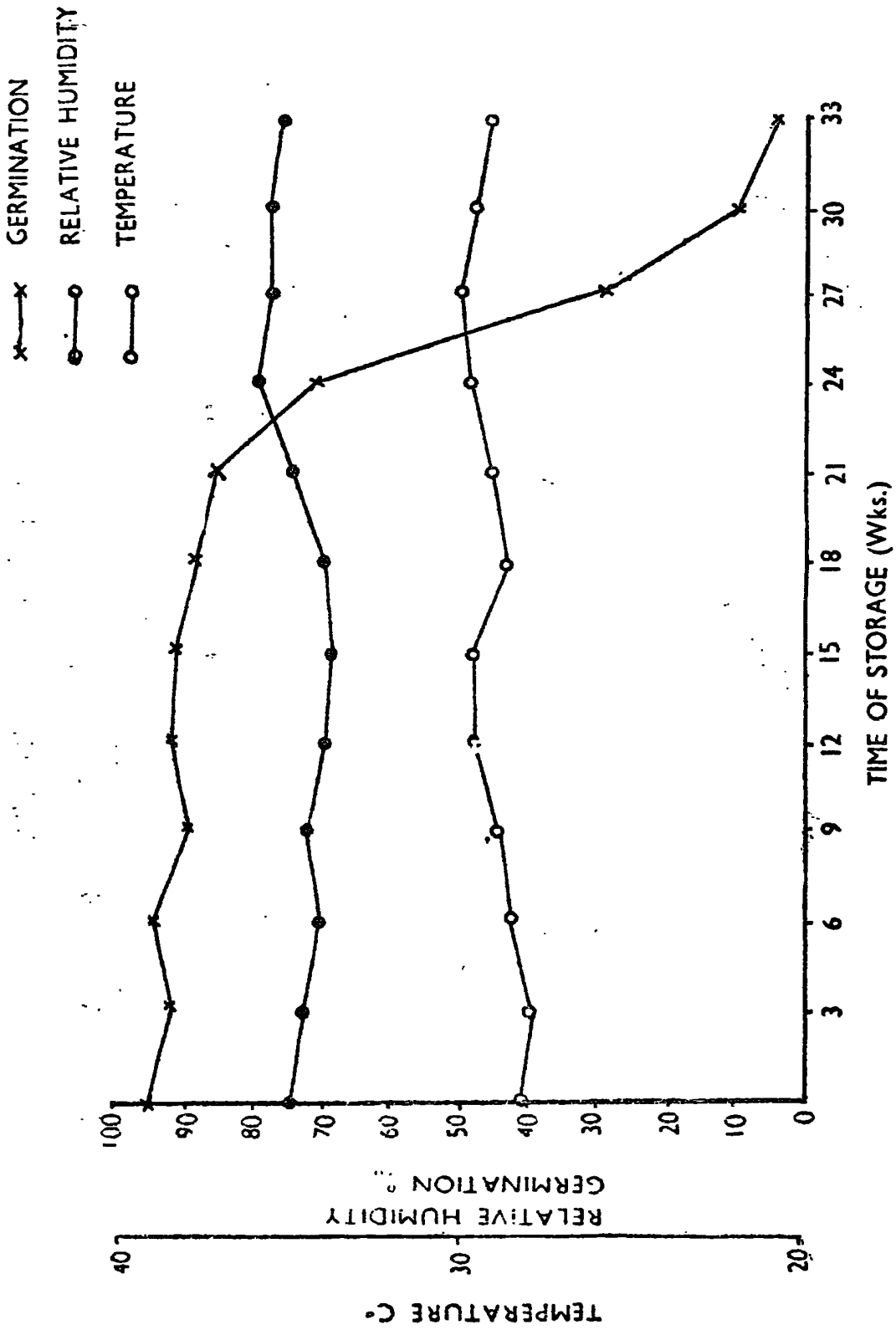


Fig. 1 Declining trend of the germination percentage of seed paddy packed in gunny or in pricked polythene together with mean relative humidity and mean temperature readings in the store room.

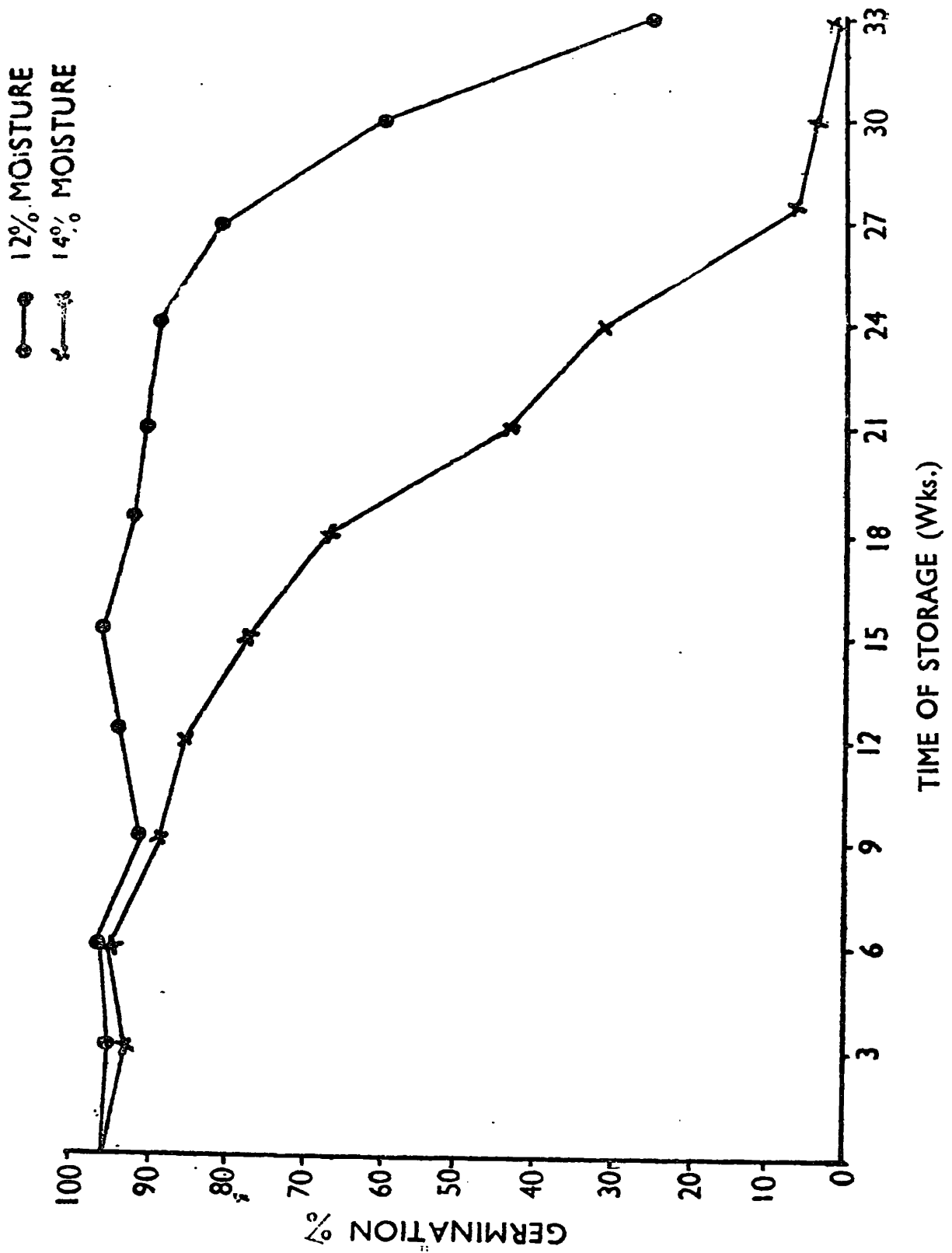


Fig. 2 Declining trends of the germination percentage of seed paddy with 12% and 14% moisture when packed in polythene.

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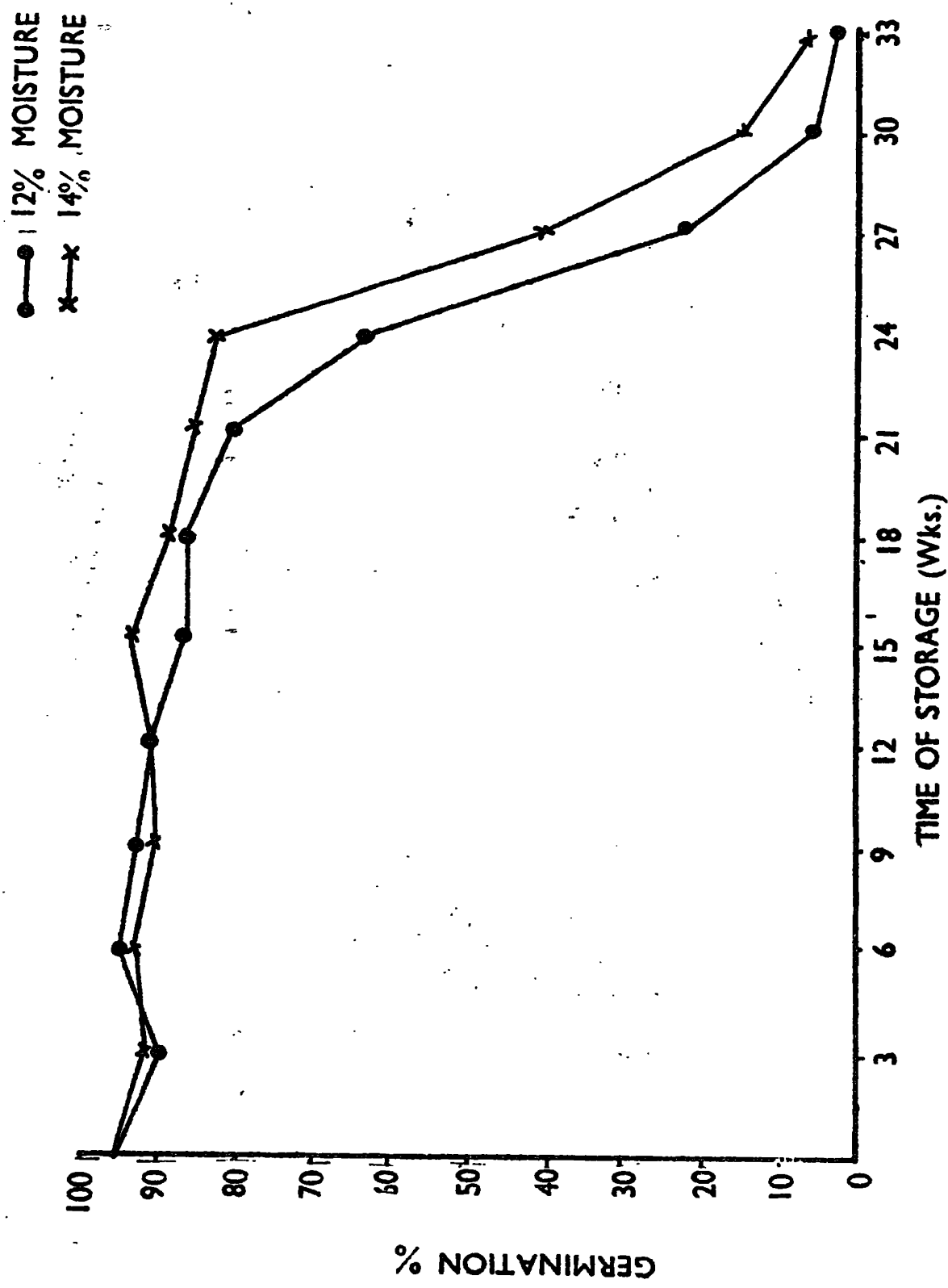


Fig. 3 Declining trends of the germination percentage of seed paddy with 12% and 14% moisture when packed in polysack.