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Enhancing the storability of bitter gourd cv. CO 1 by pelleting treatments

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Abstract : A storage study was carried out in the Department of Seed Science and Technology, TNAU, Coimbatore during 2001-03 to assess the storage potential of pelleted seeds with different botanicals *viz.*, arappu *(Albizia amara)*, pungam *(Pongamia pinnata)*, neem *(Azadirachta indica)*, notchi *(Vitex negundo)* and vasambu *(Achorus calamus)*. The treated seeds were kept in moisture vapour pervious (cloth bag) and moisture vapour proof (700 gauge polythene bag) containers under ambient conditions for six months. With regard to seed quality attributes, significant differences were observed among seed treatments, storage containers and periods of storage. The seed quality evaluations at monthly intervals revealed that increasing trend in germination per cent, speed of germination, drymatter production, vigour index, electrical conductivity, moisture content and free fatty acid content were observed with the increase in storage period. Among the seed pelleting treatments, seeds pelleted with arappu leaf powder showed superiority over other treatments and control. Arappu pelleting treatment proved to be the best in maintaining vigour and viability of seed throughout the storage period of six months. Reduction of oil content in arappu treatment was less compared to other treatments and control. Pelleting with neem leaf powder showed poor performance. With regard to containers, 700 gauge polyethylene bag proved to be superior to cloth bag in maintaining germination, vigour and drymatter production. With the advance in the storage period, an increase in electrical conductivity, moisture and free fatty acid content of seed were observed.

Key Words : Bitter gourd seeds, Pelleting, Storage, Arappu, Vigour.

Introduction

Bitter gourd or balsam pear *(Momordica charantia* L.) which is one of the most popular cucurbitaceous vegetables commonly cultivated in India lacks adequate information on the seed storage aspects. Hence, the present study has been formulated. Storage conditions have a direct effect on seed quality and loss in seed quality means poor seed performance. Good seeds need proper storage. Storage of enhanced seeds can be extended by storing under ideal conditions. The storage conditions dictate seed viability and vigour and proper packaging of seeds results in exclusion of moisture, insects and microorganism by creating a barrier to these factors (Warham, 1986). Method of storing the seeds with specific reference to the type of containers and nature of seed treatment will go a long way in prolonging the shelf life of the seed. This necessiates the storage study of pelleted seeds in bitter gourd.

Table 1. Effect of seed pelleting treatments, storage containers and periods of storage on moisture content (%) of bitter gourd cv. CO 1 seeds

Treatment	Container	Period of storage (Months)							T x C Mean	T Mean
		P_0	P_1	P_2	P_3	P_4	P_5	P_6		
T_0	C_1	7.1	7.2	7.3	7.7	8.0	8.2	8.4	7.7	7.8
	C_2	7.1	7.3	7.4	7.8	8.3	8.4	8.5	7.8	
T x P Mean		7.1	7.3	7.4	7.7	8.1	8.4	8.5		
T_1	C_1	7.1	7.2	7.2	7.4	7.5	7.8	8.1	7.5	7.5
	C_2	7.1	7.2	7.3	7.6	7.9	8.1	8.3	7.6	
T x P Mean		7.1	7.2	7.3	7.5	7.7	7.9	8.2		
T_2	C_1	7.1	7.3	7.6	7.9	8.2	8.4	8.5	7.9	7.9
	C_2	7.1	7.4	7.6	8.0	8.3	8.5	8.7	7.9	
T x P Mean		7.1	7.4	7.6	7.9	8.3	8.5	8.6		
T_3	C_1	7.1	7.3	7.4	7.7	8.1	8.3	8.4	7.8	7.8
	C_2	7.1	7.4	7.5	7.9	8.3	8.3	8.6	7.9	
T x P Mean		7.1	7.4	7.4	7.8	8.2	8.3	8.5		
T_4	C_1	7.1	7.2	7.2	7.5	7.9	8.0	8.2	7.6	7.6
	C_2	7.1	7.3	7.4	7.6	8.1	8.2	8.4	7.7	
T x P Mean		7.1	7.2	7.3	7.6	7.9	8.1	8.3		
T_5	C_1	7.1	7.2	7.4	7.6	7.9	8.2	8.3	7.7	7.7
	C_2	7.1	7.3	7.4	7.7	8.2	8.3	8.5	7.8	
T x P Mean		7.1	7.3	7.4	7.7	8.1	8.3	8.4		
PxC Mean	C_1	7.1	7.2	7.3	7.6	7.9	8.2	8.3	7.7	
	C_2	7.1	7.3	7.4	7.8	8.1	8.3	8.5	7.8	
P Mean		7.1	7.3	7.4	7.7	8.0	8.2	8.4		
		P	C	T	PxC	CxT	PxT		PxCxT	
SEd		0.02	0.01	0.04	0.03	0.03	0.05		NS	
CD (P=0.05)		0.37	0.02	0.03	0.52	0.05	0.09		NS	

Materials and Methods

A storage experiment was conducted with cleaned, graded and pelleted seeds of bitter gourd cv. CO 1 as per the following treatments. The storage study was continued for a period of six months.

Treatments

T_0 - Unpelleted control

T_1 - Arappu *(Albizia amara)* leaf powder pelleting @ 200 g kg^{-1} of seed

T_2 - Neem *(Azadirachta indica)* leaf powder pelleting @ 200 g kg^{-1} of seed

T_3 - Notchi *(Vitex negundo)* leaf powder pelleting @ 200 g kg^{-1} of seed

T_4 - Pungam *(Pongamia pinnata)* leaf powder pelleting @ 200 g kg^{-1} of seed

T_5 - Vasambu *(Acorus calamus)* rhizome powder pelleting @ 200 g kg^{-1} of seed

Containers

C_1 - Cloth bag

C_2 - 700 gauge polyethylene bag

Table 2. Effect of seed pelleting treatments, storage containers and periods of storage on germination (%) of bitter gourd cv. CO 1 seeds

Treatment	Container	P_0	P_1	P_2	P_3	P_4	P_5	P_6	T x C Mean	T Mean
To	C_1	42 (40.36)	45 (42.13)	50 (45.00)	57 (49.02)	73 (58.69)	77 (61.34)	78 (62.05)	60 (51.23)	56 (49.65)
	C_2	42 (40.39)	44 (41.55)	46 (45.00)	50 (45.00)	62 (51.95)	70 (56.80)	72 (40.39)	55 (48.06)	
T x P Mean		42 (40.39)	45 (41.84)	48 (43.85)	54 (47.01)	68 (55.32)	74 (59.07)	75 (60.05)		
T_1	C_1	49 (44.42)	55 (47.87)	63 (52.53)	81 (64.16)	93 (74.69)	94 (76.01)	94 (76.01)	76 (62.24)	72 (59.64)
	C_2	49 (44.42)	50 (45.00)	54 (47.29)	71 (57.42)	83 (65.66)	87 (68.88)	89 (70.65)	69 (57.04)	
T x P Mean		49 (44.42)	53 (46.43)	59 (49.91)	76 (60.79)	88 (70.17)	91 (72.45)	92 (73.34)		
T_2	C_1	31 (33.83)	35 (36.27)	36 (36.81)	51 (45.57)	68 (55.55)	72 (58.05)	73 (58.69)	52 (46.40)	48 (44.02)
	C_2	31 (33.83)	32 (34.45)	34 (37.66)	37 (37.46)	51 (45.57)	64 (53.13)	61 (51.35)	44 (41.63)	
T x P Mean		31 (33.38)	34 (35.36)	35 (36.26)	44 (41.51)	60 (50.56)	68 (55.85)	67 (56.09)		
T_3	C_1	38 (38.05)	41 (39.81)	44 (41.55)	62 (51.95)	70 (56.80)	74 (59.36)	74 (59.36)	56 (49.55)	54 (47.75)
	C_2	38 (38.05)	38 (38.05)	42 (40.39)	54 (47.29)	60 (50.77)	66 (54.34)	64 (52.83)	52 (45.96)	
T x P Mean		38 (38.05)	40 (38.93)	43 (40.97)	58 (49.62)	65 (53.78)	70 (56.85)	69 (56.09)		
T_4	C_1	49 (44.42)	51 (45.57)	53 (46.72)	76 (60.66)	86 (68.07)	89 (70.65)	91 (72.56)	71 (58.38)	69 (56.62)
	C_2	49 (44.42)	49 (44.42)	53 (46.43)	64 (53.13)	81 (64.16)	81 (64.16)	86 (68.07)	66 (54.87)	
T x P Mean		49 (44.42)	50 (45.00)	53 (46.57)	70 (56.89)	84 (66.12)	85 (67.04)	89 (70.32)		
T_5	C_1	31 (33.38)	48 (43.85)	52 (46.14)	62 (51.95)	76 (60.68)	80 (63.43)	84 (66.42)	62.0 (52.33)	61 (51.58)
	C_2	31 (33.38)	46 (42.70)	50 (45.00)	54 (47.29)	74 (59.36)	79 (62.73)	82 (64.93)	59 (50.8371)	
T x P Mean		31 (33.38)	47 (43.28)	51 (45.51)	58 (49.62)	75 (60.02)	80 (63.08)	83 (65.67)		
P x C Mean	C_1	40 (39.16)	46 (42.58)	50 (44.80)	65 (53.88)	78 (62.41)	81 (64.81)	82 (65.85)	63 (53.36)	
	C_2	40 (39.16)	43 (41.03)	47 (42.91)	55 (53.88)	69 (56.24)	75 (59.88)	76 (60.98)	58 (49.73)	
PMean		40 (39.16)	45 (41.80)	49 (43.86)	60 (50.61)	74 (59.33)	78 (62.34)	79 (63.41)		

	P	C	T	PxC	CxT	PxT	PxCxT
SEd	0.39	0.21	0.37	0.55	0.51	0.96	NS
CD(P=0.05)	0.78	0.42	0.72	1.10	1.02	1.91	NS

(Figures in parenthesis indicate arcsine values)

Table 3. Effect of seed pelleting treatments, storage containers and periods of storage on speed of germination of bitter gourd cv. CO 1 seeds

Treatment	Container	Period of storage (Months)							T x C Mean	T Mean
		P_0	P_1	P_{2s}	P_3	P_4	P_5	P_6		
To	C_1	4.1	4.5	5.0	6.2	9.6	9.7	12.6	7.4	7.3
	C_2	4.1	4.1	4.7	5.8	9.4	9.5	12.1	7.1	
T x P Mean		4.1	4.3	4.9	6.0	9.5	9.6	12.3		
T_1	C_1	5.6	7.5	8.2	11.2	13.4	13.5	15.4	10.7	9.9
	C_2	4.3	4.9	6.3	7.7	12.2	12.8	14.6	9.0	
T x P Mean		4.9	6.2	7.3	9.5	12.8	13.2	15.0		
T_2	C_1	3.6	4.1	4.3	4.9	8.0	8.3	10.5	6.3	5.7
	C_2	3.6	4.0	4.2	4.2	6.1	7.0	7.2	5.2	
T x P Mean		3.6	4.1	4.3	4.6	7.1	7.7	8.9		
T_3	C_1	3.6	4.4	4.7	5.4	9.6	10.4	11.6	7.1	6.9
	C_2	3.6	4.0	4.4	5.2	8.2	9.6	10.8	6.6	
T x P Mean		3.7	4.3	4.6	5.3	8.9	10.0	11.2		
T_4	C_1	4.1	4.9	6.2	8.4	12.4	12.8	14.9	9.1	8.9
	C_2	4.1	4.6	5.7	7.5	11.6	12.5	14.2	8.6	
T x P Mean		4.1	4.8	6.0	8.0	12.0	12.7	14.6		
T_5	C_1	4.1	4.7	5.4	6.4	10.7	10.8	12.9	7.9	7.8
	C_2	4.1	4.6	5.0	6.3	10.2	10.2	19.7	7.6	
T x P Mean		4.2	4.7	5.3	6.4	10.5	10.5	12.8		
PxC Mean	C_1	4.2	5.1	5.7	7.1	10.7	10.9	12.9	8.1	
	C_2	4.0	4.4	5.1	6.2	9.7	10.3	11.9	7.4	
P Mean		4.1	4.7	5.4	6.6	10.2	10.6	12.5		
		P	C	T	PxC	CxT	PxT		PxCxT	
SEd		0.15	0.08	0.14	NS	0.19	0.36		0.50	
CD (P=0.05)		0.14	0.15	0.26	NS	0.37	0.70		1.00	

The treated seeds were packed in cloth bag and hand sewn while polythene container was heat sealed and then stored under ambient (33°C temperature and 57 per cent RH) conditions for six months. Seed samples were drawn initially (Po) and subsequently at monthly (P_1, P_2, P_3, P_4, P_5 and P_6) intervals and tested for the following seed quality parameters.

Moisture content (%)

The moisture content was calculated and expressed in per cent by using the standard procedure (ISTA, 1999).

Germination (%)

The total number of 4 x 100 seeds selected at random from each pelleting treatment were placed in sterilized sand medium and allowed

Table 4. Effect of seed pelleting treatments, storage containers and periods of storage on vigour index of bitter gourd cv. CO 1 seeds

Treatment	Container	Period of storage (Months)							T x C Mean	T Mean
		P_0	P_1	P_2	P_3	P_4	P_5	P_6		
To	C_1	1393	1719	2038	2685	3840	4613	4494	2970	2728
	C_2	1393	1544	1675	2018	2838	3860	4082	2487	
T x P Mean		1393	1632	1856	2351	3339	4236	4288		
T_1	C_1	1549	2469	2864	4139	5399	6030	6313	4109	3823
	C_2	1549	2145	2401	3287	4320	5376	5688	3538	
T x P Mean		1549	2307	2632	3713	4859	5703	6000		
T_2	C_1	750	1154	1372	2106	3223	3866	3905	2339	2061
	C_2	750	982	1125	1354	2012	3213	3044	1783	
T x P Mean		750	1068	1248	1730	2618	3540	3475		
T_3	C_1	1197	1517	1751	2710	2819	4144	3432	2510	2368
	C_2	1197	1216	1483	2128	2601	3521	3432	2225	
T x P Mean		1197	1366	1617	2419	2710	3833	3432		
T_4	C_1	1784	2086	2314	3781	4936	5448	5824	3739	3477
	C_2	1784	1857	2247	2800	3933	4624	5263	3215	
T x P Mean		1784	1972	2281	3291	4434	5036	5544		
T_5	C_1	1087	1886	2179	3040	4286	4836	5124	3205	3016
	C_2	1087	1656	2045	2290	3419	4467	4815	2826	
T x P Mean		1087	1771	2112	2665	3853	4652	4969		
PxC Mean	C_1	1293	1805	2086	3077	4084	4823	4849	3145	
	C_2	1293	1567	1829	2313	3187	4177	4387	2679	
P Mean		1293	1686	1958	2695	3635	4500	4618		
		P	C	T	PxC	CxT	PxT	PxCxT		
SEd		56.4	30.15	52.22	79.76	73.85	138.15	195.38		
CD (P=0.05)		112.16	59.95	103.84	158.61	146.85	274.73	388.53		

to germinate. After the test period of 14 days the mean number of normal seedlings produced was expressed as germination percentage (ISTA, 1999).

Speed of germination

A total of 4 x 100 seeds from each treatment were placed in sterilized sand medium and allowed to germinate. The number of seeds germinated was recorded daily upto the day of final count. From the number of seeds germinated on each counting day, the rate of germination was calculated by adopting the formula and expressed in number (Maguire, 1962).

Table 5. Effect of seed pelleting treatments, storage containers and periods of storage on drymatter production (g 10 seedlings^{-1}) of bitter gourd cv. CO 1 seeds

Treatment Container		Period of storage (Months)							T x C Mean	T Mean
		P_0	P_1	P_2	P_3	P_4	P_5	P_6		
To	C_1	1.7	1.7	1.8	1.9	2.1	2.2	2.3	2.0	1.9
	C_2	1.7	1.7	1.7	1.9	2.0	2.1	2.2	1.9	
T x P Mean		1.7	1.7	1.7	1.9	2.1	2.2	2.3		
T_1	C_1	1.9	2.0	2.1	2.1	2.4	2.5	2.5	2.2	2.2
	C_2	1.9	2.0	2.1	2.1	2.4	2.5	2.5	2.2	2.2
T x P Mean		1.9	1.9	2.0	2.1	2.3	2.4	2.4	2.1	
T_2	C_1	1.6	1.7	1.7	1.7	1.9	2.2	2.2	1.8	1.8
	C_2	1.6	1.6	1.7	1.7	1.8	2.1	2.2	1.8	
T x P Mean		1.6	1.7	1.7	1.7	1.9	2.1	2.2		
T_3	C_1	1.6	1.7	1.7	1.9	2.1	2.2	2.2	1.9	1.9
	C_2	1.6	1.7	1.7	1.9	2.1	2.2	2.2	1.9	
T x P Mean		1.6	1.7	1.7	1.9	2.1	2.2	2.2		
T_4	C_1	1.7	1.8	2.0	2.1	2.3	2.4	2.4	2.1	2.1
	C_2	1.7	1.8	1.4	2.1	2.1	2.7	2.3	2.0	
T x P Mean		1.7	1.8	1.7	2.1	2.2	2.5	2.4		
T_5	C_1	1.7	1.8	2.0	2.1	2.1	2.3	2.4	2.0	2.0
	C_2	1.7	1.7	1.9	2.1	2.1	2.3	2.3	2.0	
T x P Mean		1.7	1.8	1.9	2.1	2.1	2.3	2.3		
PxC Mean	C_1	1.7	1.8	1.9	2.0	2.1	2.3	2.3	2.0	
	C_2	1.7	1.7	1.7	1.9	2.1	2.3	2.3	2.0	
P Mean		1.7	1.8	1.8	2.0	2.1	2.3	2.3		
		P	C	T	PxC	CxT	PxT		PxCxT	
SEd		0.03	0.02	0.03	0.04	0.04	0.07		0.10	
CD (P=0.05)		0.59	0.03	0.05	0.08	0.08	0.14		0.20	

Vigour index

The vigour was computed by adopting the procedure of Abdul-Baki and Anderson (1973) as given below and expressed as whole number. Vigour index = Germination percentage x mean length of root and shoot in cm.

Dry matter production (mg 10 seedlings^{-1})

Ten normal seedlings per replicate used for growth measurements were placed in a paper cover and dried under shade for 24 h and then in the hot air oven maintained at 85 ± 1°C for 24 h. The dried seedlings were cooled in a desiccator for 30 minutes, weighed and expressed in mg 10 seedlings^{-1}.

Electrical conductivity (dSm^{-1}) (Presely, 1958)

Four replicates of one hundred seeds were taken, washed with distilled water and soaked in 50 ml distilled water for 6 hours. The electrical conductivity of the seed leachate was measured in a digital conductivity meter (Type MCD - 287) with a cell constant of the electrode being one. The electrical conductivity of seed leachate was expressed in dSm^{-1}.

Oil content (%)

The seeds were decoated and the kernals from each sample were dried at 105°C in a hot air oven for 16 hours. Then they were allowed to cool in a desiccator. From, this about 5 g of the kernal was taken, ground in a porcelein morter and transferred to an extraction thimble. The thimble was then placed inside the soxhlet extractor to which sufficient quantity of ether solvent was added and heated for 6 h until 6 to 8 Siphonings were completed. Then, the extraction flask with the Siphonings was taken out and placed in a hot air oven maintained at 60°C to evaporate the ether completely. The percentage of oil content was then calculated by using the following formula.

$$\text{Oil content (per cent)} = \frac{\text{Oil weight (g)}}{\text{Sample weight (g)}} \times 100$$

The determination of oil content was duplicated for each sample.

Free fatty acid (%) (Christiansen and Moore, 1961)

The quantity of oil extracted was mixed with 25 ml of neutralized 95 per cent alcohol. The mixture was heated to boiling and titrated while hot, against 0.02 N NaOH solution to a faint pink end point using phenolphthalein as an indicator. The total free fatty acid content was calculated as per cent oleic acid using the following formula.

Per cent of total free fatty acid content (as oleic acid)

$$\frac{28.2 \times \text{(N) of alkali} \times \text{ml of alkali used}}{\text{Weight of oil (g)}}$$

Results and Discussion

Storage conditions have direct effect on seed quality. Information on storage of seeds to serve the vigour and viability from harvest to next planting season and for carryover purposes is of prime importance in any seed production programme.

The storage study was carried out to elucidate information on the storage performance of pelleted seeds by using botanicals which may influence the seed shelf life. In the present investigation, leaf powders *viz.*, notchi, neem, pungam and arappu and the rhizome powder of vasambu @ 200 g kg^{-1} of seeds were used for pelleting the seeds and they were stored in 700 gauge polyethylene bag and cloth bag for a period of six months. The observations *viz.*, moisture content, germination, speed of germination, vigour index, drymatter production, electrical conductivity, oil and free fatty acid content were recorded at monthly intervals.

From the results, it was understood that pelleting of bitter gourd seeds with arappu leaf powder @ 200 g kg^{-1} of seeds improved the storage potential of seeds. This was followed by pungam leaf powder @ 200 g kg^{-1} of seeds. This was in conformity with Sabir - Ahamed (1989) and Nargis (1995). This might be due to the differential nature of hygroscopicity among the different pelleting materials. This was also confirmed by Viswanatha Reddy (1995) who opined that brinjal seeds pelleted with arappu and pungam leaf powders maintained its superiority in germinability than the untreated control even after 8 months of storage. Pelleting with neem leaf powder showed poor performance which was supported by Saraswathi (1993) in cotton.

In the present study, the observation on moisture content revealed that seeds pelleted with arappu leaf powder had not enhanced moisture absorption but slightly reduced it compared to other treatments and control. The results expressed that botanicals in general restricted the moisture transmission from atmosphere to the seed and *vice versa.* The possible reason might be due to the availability of lesser moisture to the seed for attaining equilibrium, as the leaf powders were the first to contact with moisture content of the surrounding atmosphere and absorbed the moisture readily than seeds. In India, the seeds are generally stored in cloth bag or gunny bags or other porous materials under ambient conditions, thus giving free access to the environmental moisture to the seed. In polyethylene bag, the polyethylene layer permits less moisture at high temperature whereas in cloth bag the moisture exchange is quite frequent and the seeds stored in it are subjected to fluctuations in seed moisture leading to an increase in seed moisture content and favoured harbouring of fungus which are responsible for the deterioration of seeds. The results in these aspects had been reported by Jayabharathi (1982) and Jegathambal (1992) in soybean and Arul Prabhu (1998) in pole bean. Increased moisture content deteriorate the seeds quickly. Among the physiological manifestation, the germination potential, root and shoot length of the seedlings, drymatter production and vigour index are important for the assessment of storage potential of the seed. In the present study, under ambient conditions of storage, bitter gourd seeds subjected to different pelleting treatments recorded higher germination, speed of germination, vigour index and drymatter production at the end of six months as against initial evaluation. Increase in measured percentage can be caused by the gradual breaking of seed dormancy. At all the storage periods, the seeds pelleted with arappu leaf powder @ 200 g kg^{-1} of seed was superior over other treatments in maintaining vigour and viability. In this investigation, the maximum mean germination of 72 per cent was obtained in arappu pelleted seed, compared to other treatments and control. Arappu pelleted seed showed 22 per cent higher germination than control. The improvement in vigour due to this treatment was 28.6 per cent. Deterioration of vigour in stored seed was associated with weakening of cell membranes (Heydecker, 1972). The better root and shoot length of the above said treatment was due to low moisture absorption by seed. Thus the less moisture content preserve the physiological parameters of the seed. This is in conformity with the results of Geethalakhsmi and Venugopal (1998) in green gram and Nakka *et al.* (1999) in soybean. Next to the arappu and pungam leaf powders, the seeds pelleted with vasambu rhizome powder performed well in maintaining the viability and vigour in storage and this was supported by Subramanian (1949), Saxena and Srivastava (1972), Pandey *et al.* (1976) and Paremeswari (2002). The beneficial effect of vasambu rhizome powder on the maintenance of seed quality was due to the presence of active principle keta asarone which preserved the genetic storage potential of seed (Schmidt *et al.,* 1991).

Electrical conductivity of the seed leachate as a measure of membrane integrity is considered as a good index for seed viability and vigour. Seeds pelleted with leaf powders of arappu, pungam and rhizome powder of vasambu recorded lower electrical conductivity and free fatty acid content than other treatments or

Table 6. Effect of seed pelleting treatments, storage containers and periods of storage on electrical conductivity (dSm^{-1}) of bitter gourd cv. CO 1 seeds

Treatment	Container	Period of storage (Months)							T x C Mean	T Mean
		P_0	P_1	P_2	P_3	P_4	P_5	P_6		
T_0	C_1	0.10	0.13	0.15	0.16	0.19	0.23	0.29	0.18	0.19
	C_2	0.10	0.13	0.15	0.19	0.20	0.27	0.31	0.19	
T x P Mean		0.10	0.13	0.15	0.17	0.20	0.25	0.30		
T_1	C_1	0.10	0.10	0.10	0.12	0.16	0.19	0.20	0.14	0.15
	C_2	0.10	0.12	0.11	0.16	0.19	0.20	0.22	0.16	
T x P Mean		0.10	0.11	0.10	0.14	0.17	0.20	0.21		
T_2	C_1	0.10	0.14	0.15	0.17	0.19	0.26	0.30	0.19	0.21
	C_2	0.10	0.16	0.19	0.21	0.28	0.31	0.32	0.22	
T x P Mean		0.10	0.15	0.17	0.19	0.23	0.28	0.31		
T_3	C_1	0.10	0.14	0.15	0.17	0.19	0.25	0.30	0.18	0.19
	C_2	0.10	0.14	0.15	0.19	0.23	0.30	0.32	0.20	
T x P Mean		0.10	0.14	0.15	0.18	0.21	0.28	0.31		
T_4	C_1	0.10	0.11	0.11	0.12	0.17	0.20	0.22	0.15	0.15
	C_2	0.10	0.11	0.12	0.14	0.17	0.22	0.22	0.15	
T x P Mean		0.10	0.11	0.12	0.13	0.17	0.21	0.22		
T_5	C_1	0.10	0.12	0.12	0.15	0.17	0.23	0.23	0.16	0.17
	C_2	0.10	0.13	0.15	0.18	0.21	0.23	0.23	0.18	
T x P Mean		0.10	0.13	0.14	0.17	0.19	0.23	0.23		
P x C Mean	C_1	0.10	0.12	0.13	0.15	0.18	0.23	0.26	0.17	
	C_2	0.10	0.13	0.14	0.17	0.21	0.26	0.27	0.10	
PMean		0.10	0.13	0.14	0.16	0.20	0.24	0.26		
		P	C	T	PxC	CxT	PxT	PxCxT		
SEd		0.001	0.001	0.001	0.002	0.002	0.003	0.005		
CD (P=0.05)		0.003	0.002	0.002	0.004	0.034	0.006	0.009		

control. Similar results were obtained by Balaji (1990) and Saraswathi (1993) in cotton and by Nargis (1995) in tomato. This might be due to slow down of ageing in pelleted seed with the time of storage which caused minimum damage to membrane system and minimum loss in membrane integrity leading to less leakage of salts and minerals in the seed leachate.

In the present investigation, the electrical conductivity of the seed leachate was always more in the control compared to arappu and pungam leaf powder pelleted seeds. Auto - oxidation involves the production of free radicals from the unsaturated fatty acids (Horman and Mattick, 1976). Free radicals may damage cellular membranes, react with

Table 7. Effect of seed pelleting treatments, storage containers and periods of storage on oil content (%) of bitter gourd cv. CO 1 seeds

Treatment	Container	Period of storage (Months)							T x C Mean	T Mean
		P_0	P_1	P_2	P_3	P_4	P_5	P_6		
To	C_1	17.9	17.9	17.6	17.3	17.0	16.6	16.5	17.2	17.2
	C_2	17.9	17.9	17.6	17.2	16.9	16.3	16.3	17.1	
T x P Mean		17.9	17.9	17.6	17.2	16.9	16.4	16.4		
T_1	C_1	17.9	17.9	17.9	17.6	17.2	16.9	16.9	17.5	17.4
	C_2	17.9	17.9	17.9	17.5	17.1	16.8	16.7	17.4	
T x P Mean		17.9	17.9	17.9	17.5	17.2	16.8	16.8		
T_2	C_1	17.9	17.9	1.75	17.2	16.8	16.3	16.3	17.1	17.1
	C_2	17.9	17.9	1.74	17.1	16.5	16.2	16.1	17.0	
T x P Mean		17.9	17.9	17.5	17.2	16.7	16.3	16.2		
T_3	C_1	17.9	17.9	17.5	17.3	16.9	16.5	16.4	17.2	17.1
	C_2	17.9	17.9	17.5	17.2	16.7	16.2	16.2	17.1	
T x P Mean		17.9	17.9	17.5	17.3	16.8	16.4	16.3		
T_4	C_1	17.9	17.9	17.8	17.6	17.0	16.8	16.8	17.4	17.4
	C_2	17.9	17.9	17.7	17.4	17.1	16.6	16.6	17.3	
T x P Mean		17.9	17.9	17.8	17.5	17.1	16.7	16.7		
T_5	C_1	17.9	17.9	17.6	17.5	17.0	16.8	16.6	17.3	17.3
	C_2	17.9	17.9	17.65	17.3	17.0	16.5	16.5	17.2	
T x P Mean		17.9	17.9	17.6	17.4	17.0	16.6	16.5		
PxC Mean	C_1	17.9	17.9	17.7	17.4	17.0	16.6	16.6	17.3	
	C_2	17.9	17.9	17.6	17.3	16.9	16.4	16.4	17.2	
P Mean		17.9	17.9	17.6	17.3	16.9	16.5	16.5		
		P	C	T	PxC	CxT	PxT		PxCxT	
SEd		0.04	0.02	0.04	NS	NS	0.10		NS	
CD (P=0.05)		0.08	0.04	0.07	NS	NS	0.19		N	

macromolecules and form hydroperoxides (Harrington, 1972; Leshem, 1981). Alternatively, peroxidation may lead to formation of epoxy and / or hydroxy fatty acids (Moll *et al.*, 1979; Mead, 1980). These oxygenated compounds are more polar than the parent compounds, and this change of polarity would lead to membrane malfunction. Arappu leaf powder pelleting treatment recorded lower electrical conductivity (0.15 dSm^{-1}) probably due to better membrane stability. Loss of germinability was positively correlated with the extent of leaching of metabolites from seed. The seeds treated with neem leaf powder recorded higher electrical conductivity than control. This was in conformity with Eevera (2000) in black gram.

Increased leaching of electrolytes resulted in vigour decline possibly caused by membrane leakage (Koostra and Horrington, 1969). The electrical conductivity of leachate was more

Table 8. Effect of seed pelleting treatments, storage containers and periods of storage on free fatty acid (%) of bitter gourd cv. CO 1 seeds

Treatment	Container	Period of storage (Months)							T x C Mean	T Mean
		P_0	P_1	P_2	P_3	P_4	P_5	P_6		
T_0	C_1	1.3	2.6	2.8	3.0	3.2	3.3	3.4	2.8	2.9
	C_2	1.3	2.8	3.0	3.2	3.3	3.4	3.4	2.9	-
T x P Mean		1.3	2.7	2.9	3.1	3.3	3.3	3.4		
T_1	C_1	1.3	1.9	2.3	2.5	2.9	3.1	3.2	2.5	2.5
	C_2	1.3	2.1	2.5	2.8	3.0	3.3	3.3	2.6	
T x P Mean		1.3	2.0	2.4	2.7	3.0	3.2	3.3		
T_2	C_1	1.3	2.8	3.1	3.2	3.3	3.4	3.5	2.9	3.0
	C_2	1.3	3.0	3.2	3.4	3.5	3.5	3.6	3.1	
T x P Mean		1.3	2.9	3.2	3.3	3.4	3.5	3.6		
T_3	C_1	1.3	2.7	3.0	3.1	3.2	3.3	3.5	2.9	2.9
	C_2	1.3	2.9	3.1	3.2	3.4	3.4	3.5	3.0	
T x P Mean		1.3	2.8	3.1	3.2	3.3	3.4	3.5		
T_4	C_1	1.3	2.3	2.6	2.7	3.0	3.2	3.2	2.6	2.7
	C_2	1.3	2.5	2.8	3.0	3.1	3.3	3.3	2.8	
T x P Mean		1.3	2.4	2.7	2.9	3.1	3.2	3.3		
T_5	C_1	1.3	2.6	2.8	2.9	3.1	3.2	3.3	2.7	2.8
	C_2	1.3	2.7	2.9	3.1	3.2	3.3	3.4	2.8	
T x P Mean		1.3	2.6	2.8	3.0	3.2	3.3	3.4		
P x C Mean	C_1	1.3	2.5	2.8	2.9	3.1	3.3	3.3	2.7	
	C_2	1.3	2.7	2.9	3.1	3.3	3.4	3.4	2.9	
P Mean		1.3	2.6	2.8	3.0	3.2	3.3	3.4		
		P	C	T	PxC	CxT	PxT	PxCxT		
SEd		0.02	0.01	0.02	0.03	NS	0.05	NS		
CD (P=0.05)		0.04	0.02	0.03	0.06	NS	0.10	NS		

in cloth bag than 700 gauge polyethylene bag and thus indicated the quick vigour loss in cloth bag. Electrical conductivity of the seed leachate increased with increase in the storage period from initial to six months. The leaching of electrolytes and free amino acids from seeds were due to deterioration of the seed (Ching and School Craft, 1968).

Biochemical changes occurring in the major seed reserves *viz.*, oil, protein and free fatty acid were found to affect the seed quality.

Similar efficacy of botanicals for seed management to protect seed against initial biochemical deterioration was also observed by Pushpamma *et al.* (1985) in bengalgram and Parameswari (2002) in pigeonpea.

In the present investigation, seeds pelleted with arappu leaf powder recorded more oil content than control and other treatments. However, the improvement due to this treatment over control was only 1.2 per cent. The reduction in oil content was associated with increase in storage period. In the present study, seeds stored in 700 gauge polyethylene bag recorded superiority in all the parameters than cloth bag, irrespective of treatment and period of storage. This is due to less absorption of moisture by the pelleted seed stored in moisture vapour proof container.

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