Seed Research, Vol. 35(1): 58-65, 2007

Studies on Seed Colouring in Redgram, Blackgram and Bengalgram

P. HARINATH BABU, VILAS A. TONAPI[1], N.A. ANSARI, VARANAVASIAPPAN[1], C.H. RAVINDER REDY[2], S.S. NAVI[3] AND N. SEETHARAMA

Department of Genetics and Plant Breeding & Seed Science and Technology, Acharya N G Ranga Agricultural University, Rajendranagar, Hyderabad 500 030

ABSTRACT The investigations on the effect of seed colouring of redgram, blackgram and bengalgram seeds encompassing 25 dyes were conducted to identify non-deleterious and deleterious dyes based on their effect on seed quality. The dyes namely Rhodamine-B, Fuchsine and Titan yellow for redgram, Rhodamine-B, Fuchsine and Phenol red for blackgram and Rhodamine-B, Crystal violet, Titan yellow for bengalgram were found to be the best dyes for seed colouring at 0.75% concentration. In this paper we discuss developing colour standards for redgram, blackgram and bengalgram seeds and their resultant implications for Indian seed industry.

Key words: Seed colouring, redgram, blackgram, bengalgram

The seed colouring in the international arena resumed with the development of colour standards in Canada, United States of America and other European countries as per policies regarding colouration of treated seeds and trade memorandum issued on July 13, 1967 [1]. Different types of dyes have been used successfully for colouring seeds, including acid dyes, basic dyes, direct dyes and pigments. The basic dyes are used most frequently because of their strong, brilliant shades, which can provide distinctive colour in spite of the natural colouration of the seeds, and also because of their economy, on an equal colour basis, versus other dye types. Dye is added to the seeds as solution or suspension and blended to give an even coverage. The seed processors colour them because it is required by law to avoid accidental use of treated seeds as food or feed. Some people colour seeds with a specific colour as a trademark, just to identify their seeds. But, to use such chemical dyes, it is necessary to prove that they are non-toxic to the seeds.

Till date there are very few and isolated studies in India to establish colour standards to pave the way for coloring the seeds by incorporating the provisions in the seed quality control and seed trade. Since the literature scan has indicated absence of any relevant literature in developing colour standards in India except the work of Tonapi [2] and Tonapi and Karivaratharaju [3] in sorghum, Vivekanandan [4] and Basavaraj and Kurdikeri [5] in soybean. In this paper we discuss developing colour standards for redgram, blackgram and bengalgram and their resultant implications for Indian seed industry.

MATERIALS AND METHODS

The investigations, on seed colouring were conducted with redgram (cv. LRG-30), blackgram (cv. LBG-7) and bengalgram (cv. Annegeri) encompassing 25 dyes namely Rhodomine-B, Cotton blue, Fuchsine, Neutral Red, Gentian Violet. Methylene blue, Crystal violet, Congored, Fast green, Bromocresol Purple, Phenol red, Nigrosine,

[1]National Research Centre for Sorghum, Rajendranagar, Hyderabad 500 030, [2]International Crops Research Institute for Semi Arid Tropics, Patancheru 502 324 [3]Department of Plant Pathology, 351 Bessey Hall, College of Agriculture, Iowa State University, Ames, Iowa 50011-1020, USA

Received July 2005 Revised August 2006 Accepted September 2006

Erichro black T, Ammonium purpureate (mureoxide), Bromocresol green, Malachite green, Methyl red, Methyl orange, Titan yellow, Indigo carmine along with commercially available natural dyes in the market namely Kumkum, Yellow, Pink, Blue and Brick red to develop and recommend color standards after assessing their effect on seed quality. The chemical composition of the dyes is given in Table 1.

Table 1. Chemical and natural dyes used in seed colouring studies

S.No.	Dye	Chemical composition
Chemical dyes		
1.	Indigo caramine	$C_{16}H_8N_2O_2$ $(So_3Na)_2$
2.	Titan yellow	Dehydrothio-P-toluidine
3.	Methyl orange	$Me_2NC_6H_4N$: $NC_6H_4SO_2Na$
4.	Methyl Red	$Me_9NC_6H_4N$: NC_6H_4COOH
5.	Nigrosine	$C_{38}H_{27}N_3$
6.	Erichro Black-T	$C_{20}H_{12}N_3O_7Sna$
7.	Ammonium purpureate	(Mureoxide) $(NH_4)_4$ P_2O_7
8.	Boromocresol green	$C_{21}H_{14}Br_4O_5S$
9.	Bromocresol purple	$C_{19}H_{10}Br_2Cl_2O_2S$
10.	Crystal violet	$C_{25}H_{30}CIN_3$
11.	Malachite green	$Me_2NC_6H_4C_6H_5C$: $NC_6H_4Me_2Cl$
12.	Congo red	$C_{32}H_{22}O_6N_6S_2Na_2$
13.	Phenol Red	$C_{19}H_{14}O_5S$
14.	Cotton Blue	$C_{32}H_{25}N_3O_9S_3Na_2$
15.	Gentian violet	$C_{25}H_{30}CIN_3$
16.	Fuchsine	$C_{20}H_{17}N_3Na_2O_9S_3$
17.	Methylene Blue	$C_{19}H_{10}Br_2C_{12}O_2S$
18.	Rhodamine-B	$C_{28}H_{31}CIN_2O_3$
19.	Neutral red	$Me_2NC_6H_3N$: $NC_6H_2MeNH_2.HCl$
20.	Fast green	$C_{37}H_{34}N_2Na_2O_{10}S_3$
Natural dyes		
21.	Natural dye - Kumkum	
22.	Natural dye - Brick Red	
23.	Natural dye - Blue	
24.	Natural dye - Yellow	
25.	Natural dye - Pink	
26.	Control	

All the dyes were prepared at 0.75 per cent concentration by dissolving 0.25 gm of dye in 16.5 ml water and 15.0 ml ethylene glycol [2].

In order to obtain the desired dye intensity, individual dye solutions in specified quantities were added on to 100g of seeds of each variety placed in a 1000 ml Erlenmayer flask, slowly down the sides of flask with a pipette. The flask was shaken for 3-5 minutes to give uniform coverage of individual dye to the seed. The seeds thus coloured were subjected for laboratory evaluation to assess the effect of these dyes on seed quality and field emergence as influenced by various biotic and abiotic factors.

The effect of seed coloring dyes on seed germination, root and shoot length, dry weight of seedlings, speed of germination, field emergence and seed germination in exhaustion test and speed of germination were recorded following. International Seed Testing Association Rules [6]. Seed vigor was assessed through vigor index calculated as the product of root length and seed germination and expressed as absolute value [7]. Electrical conductivity of seed leachate [8], seed germination in chemical soak test [9], seed germination in D-manitol soak test [10], a -amylase activity [11] and dehydrogenase activity [12] were evaluated to assess the effect of dyes on biochemical composition of seeds. All the tests were conducted in four replications consisting of 400 seeds. Fisher's method of analysis of variance was applied for data analysis. Critical differences were calculated at $P = 0.05$.

RESULTS AND DISCUSSION

Influence of seed colouring on germinative, physiological and biochemical indices of seeds in redgram (cv. LRG-30).

In redgram, the various dyes had both promoting as well as deleterious impact significantly on seed germination (97-61%), root length (14.47-9.77 cm), shoot length (16.50-10.87

cm), dry weight of seedlings (0.607-0.397 g), vigour index (1314-680), field emergence (96.3-80.0%) and speed of germination (26.73-20.03).

The biochemical and enzyme activity including performance under stress had wide ranging influences in terms of membrane integrity as indicated by electrical conductivity (377-447 m mhos/cm), a-amylase activity (3.70-2.90 mm), dehydrogenase activity (0.38-0.30 OD). The range of seed germination as influenced by seed colouring in redgram under stress tests were in the range of 89-59 per cent, 87-53 and 80-48 per cent in chemical soak test, exhaustion test and D-mannitol soak test respectively. The detailed analysis of the data, in redgram could categorise all the 25 dyes into best, mid range and most deleterious in relation to their effect on seed quality. The dyes namely Rhodamine-B, Fuchsine, Titan yellow, Methylene blue and Mureoxide are the best and most favoured dyes in view of their promoting effect on seed quality in redgram.

The most deleterious dyes in redgram were natural dyes, Kumkum, Blue, Yellow and Pink since these dyes available in the market are chemical formulations that contain harmful elements which are injurious to the seeds as executed in seed germination, field emergence and the total deleterious impact on physiological and biochemical parameters involved in this investigation. The remaining dyes were classified as mid range in terms of the fact that they were not very deleterious but they certainly reduced the total seed quality components significantly when compared to most favoured dyes as cited above.

Influences of seed colouring on germinative, physiological and biochemical indices of seeds in blackgram cv. LBG-7

In blackgram, the various dyes had both promoting as well as deleterious impact significantly on seed germination (93-61%), root length (12.80-6.77 cm), shoot length (18.17-11.2 cm), dry weight of seedlings (0.200-0.090 g), vigour index (1032-401), field emergence (96.0-76.6%) and speed of germination (31.33-20.6).

The biochemical and enzyme activity including performance under stress had wide varying influences in terms of membrane integrity as indicated by electrical conductivity (362-375 m mhos/cm), a-amylase activity (2.7-2.2 mm), dehydrogenase activity (0.35-0.29 OD). The range of seed germination as influenced by seed colouring in blackgram under stress tests were in range of 83-57 per cent, 81-53 per cent and 49-29 per cent in chemical soak test, exhaustion test and D-mannitol soak test respectively. The detailed analysis of data, in blackgram could conveniently help to categorise all the 25 dyes into best, mid range and most deleterious in relation to their effect on seed quality. The dyes namely Rhodamine-B, Natural dye Yellow, Phenol red, Bromocresol purple and Fuchsine are the best and most favoured dyes in view of their promoting effect on seed quality in blackgram.

The most deleterious dyes in blackgram were natural dyes Pink and Brick red. The remaining dyes were classified as mid range in terms of the fact that they were not very deleterious, they certainly reduced the total seed quality components significantly when compared to most favoured dyes as listed above.

Influence of seed colouring on germinative, physiological and biochemical indices of seeds in bengalgram cv. Annegeri

The various seed colouring dyes involved in developing colour standards also exhibited both positive and deleterious influences on seed quality parameters in the range viz., seed germination (98-81%), root length (19.3-11.7 cm), shoot length (24.5-15.9 cm), dry weight of seedlings (1.327-0.563 g), vigour index (1699-1035) and speed of germination (31.2-1.6).

The biochemical and enzyme activity including performance under stress had wide varying influences in terms of membrane integrity as indicated by electrical conductivity (385-412 m mhos/cm), a-amylase activity (3-2.03 mm) and dehydrogenase activity (0.33-0.26 OD). The range of seed germination as influenced by seed colouring in blackgram under stress tests were in range of 89-82 per cent, 86-77 per cent and 78-69 per cent in chemical soak test, exhaustion test and D-mannitol test respectively.

The detailed analysis of the data could categorise all the 25 dyes into best, mid range and

Table 2. Influence of seed colouring on seed germination (%) and seedling growth in redgram (cv. LRG-30)

Name of the dye	Germination (%)	Root length (cm)	Shoot length (cm)	Dry wt. of seedling	Vigour index (RLxG%)	Field emergence	Speed of ger.	EC (μ mhos/ cm)	α-amalyse activity (OD)	Dehydrogenase activity
Rhodamine-B	95(79)#	12.10	16.50*	0.450*	1150	90.0	20.10*	400*	3.70	0.380
Cotton Blue	97(84)	12.30	14.47	0.467	1193	94.0	24.36	399*	3.60	0.370
Fuchsine	97(84)	12.33	13.40	0.600	1199	90.0	23.40	399*	3.70	0.380
Neutral Red	94(78)	11.87	14.00	0.543	1123	93.3	26.73*	400*	3.60	0.380
Gentian violet	84(67)	13.07	12.60	0.523	1107	87.6	22.93	430*	3.30*	0.330*
Methylene Blue	97(84)	13.50*	14.33	0.570	1314	96.0	24.56	429*	3.30*	0.330*
Crystal violet	93(77)	13.10	13.30	0.513	1219	87.6	25.03	377*	3.60	0.370*
Congo red	80(63)	11.03	13.90	0.423*	890*	89.3	22.36	398*	3.60	0.370*
Fast green	84(67)	11.77	13.83	0.510	997	89.3	20.46*	399*	3.70	0.370
Bromocresol purple	84(66)	12.63	11.17	0.450*	1065	80.0*	20.03*	400*	3.70	0.360*
Phenol Red	94(78)	12.83	14.20	0.573	1203	94.3	24.83	428*	3.20*	0.320*
Nigrosine	84(67)	13.03	13.57	0.480	1104	86.6	21.60	400*	3.60	0.350*
Erichro black-T	94(78)	12.40	13.40	0.510	1166	89.3	25.03	435*	3.20*	0.320*
Mureoxide (Amm.pur)	89(70)	14.47	15.67*	0.510	1287	90.6	21.50	441	3.60	0.360*
Bromocresol green	94(78)	12.73	13.50	0.570	1197	93.6	24.80	399*	3.70	0.370
Malachite green	85(67)	13.10	12.37	0.497	1113	86.6	23.06	400*	3.60	0.366*
Methyl Red	84(67)	12.10	14.50	0.480	1024	89.6	23.76	439*	3.30*	0.320*
Methyl Orange	84(66)	12.60	13.43	0.530	1069	96.3	25.26	440	3.20*	0.320*
Titan yellow	90(75)	13.73	14.77	0.530	1238	91.3	21.36	399*	3.60	0.370
Indigo caramine	81(64)	12.87	11.53	0.450*	1042	96.0	23.30	400*	3.60	0.370
Natural dye-kumkum	61(56)	10.33*	12.73	0.397*	680*	93.3	22.03	445*	3.10*	0.300*
Natural dye-yellow	78*(62)	9.77*	10.87*	0.477	765*	84.0*	20.36*	442*	3.00*	0.310*
Natural dye-pink	85(67)	11.50	13.07	0.507	982	92.0	25.56	445	3.00*	0.300*
Natural dye-Blue	88(73)	11.58	11.70	0.580	1019	82.0*	20.66*	447	3.10*	0.300*
Natural dye-Brickred	91(80)	12.27	13.90	0.607	1125	83.0*	21.20	443	2.90*	0.300*
Control	94(78)	12.30	13.20	0.557	1160	91.3	23.66	398	3.70	0.380
S.Ed±	7.42	0.77	1.05	0.04	123.77	2.99	1.34	2.05	0.088	0.006
C.D (0.05)*	15.44	1.61	2.19	0.09	257.44	6.03	2.79	4.14	0.162	0.012

#Figures in parentheses are arcsine transformed values.

Table 3. Influence of seed colouring on seed germination (%) and seedling growth in blackgram (cv. LBG-7)

Name of the dye	Germination (%)	Root length (cm)	Shoot length (cm)	Dry wt. of seedling	Vigour index (RLxG%)	Field emergence	Speed of ger.	EC (μ mhos/cm)	α-amalyse activity (OD)	Dehydrogenase activity
Rhodamine-B	88(70)#	9.87	14.60	0.143	869	87.3*	23.00	362	2.70	0.350
Cotton Blue	71(57)*	10.17	15.89	0.123*	710	84.0*	22.60	362	2.60	0.340
Fuchsine	71(57)*	9.73	18.17*	0.107*	694	90.0	23.36	363	2.70	0.350
Neutral Red	58(50)*	9.23	15.83	0.097*	542*	93.6	30.53*	363	2.60	0.350
Gentian violet	93(78)	9.13	14.43	0.147	856	90.0	21.66	367*	2.40*	0.320*
Methylene Blue	83(66)	10.30	15.63	0.133	857	90.6	29.93*	370*	2.20*	0.320*
Crystal violet	79(62)	9.80	13.87	0.140	111	76.6*	20.60*	362	2.60	0.340
Congo red	80(63)	8.67	13.77	0.123*	705	86.0*	21.13*	362	2.60	0.350
Fast green	65*(53)	9.23	14.23	0.113*	607*	94.0	24.36	363	2.60	0.340
Bromocresol purple	74(59)	11.37*	15.87	0.114*	854	9.50	27.40	362	2.70	0.350
Phenol Red	80(63)	12.80*	15.20	0.097*	1032*	88.0*	25.43	370*	2.30*	0.300*
Nigrosine	80(63)	10.20	13.70	0.127	819	94.0	22.66	363	2.60	0.350
Erichro black-T	71*(57)	10.33	14.50	0.127	734	87.3*	25.66	372*	2.20*	0.320*
Mureoxide (Amm.pur)	84(66)	11.67*	13.40	0.117*	921	80.6*	26.66	364	2.60	0.326
Bromocresol green	66*(54)	7.97	14.77	0.157	520*	89.0*	21.43	363	2.60	0.350
Malachite green	65*(53)	8.30	14.67	0.123*	544*	95.0	28.00	364	2.70	0.340
Methyl Red	80(63)	9.70	16.03	0.140	782	83.0*	22.66	372*	2.40	0.320*
Methyl Orange	61(51)	8.50	15.43	0.103*	521*	82.3*	20.73*	372*	2.20*	0.300*
Titan yellow	67(55)	8.73	16.10	0.120*	590*	85.3*	27.33	362	2.60	0.340
Indigo caramine	71*(57)	9.37	15.30	0.150	670	9.20	27.33	363	2.60	0.340
Natural dye-kumkum	72*(63)	9.33	15.10	0.143	679	77.3*	24.33	372*	2.30*	0.300*
Natural dye-yellow	88(73)	9.40	16.63*	0.200	835	77.3*	22.50	375*	2.20*	0.290*
Natural dye-pink	70*(57)	7.10*	11.23	0.146	501*	85.3*	23.16	370*	2.20*	0.300*
Natural dye-Blue	75(60)	6.77*	14.27	0.140	504*	83.6	31.33*	372*	2.20*	0.300*
Natural dye-Brickred	62*(53)	6.83*	15.33	0.090*	401*	90.0	24.00	370*	2.20*	0.290*
Control	88(70)	9.33	13.30	0.166	821	96.0	25.50	362	2.70	0.350
S.Ed±	7.46	0.91	1.33	0.02	94.12	3.22	21.6	1.78	0.12	0.01
C.D (0.05)*	15.53	1.90	2.77	0.04	195.77	6.48	43.6	3.59	0.24	0.02

#Figures in parentheses are arcsine transformed values.

Table 4. Influence of seed colouring on seed germination (%) and seedling growth in bengalgram (cv. Annegiri)

Name of the dye	germination (%)	Root length (cm)	Shoot length (cm)	Dry wt. of seedling	Vigour index (RLxG%)	Field emergence	Speed of ger.	EC (μ mhos/cm)	α-amalyse activity (OD)	Dehydrogenase activity
Rhodamine-B	98(85)#	17.20	22.43	1.133	1691	96.0	25.06	387	2.90	0.320
Cotton Blue	94(82)	11.70*	18.27	1.237	1105*	91.0	25.86	386	2.90	0.320
Fuchsine	92(76)	14.70	20.87	1.327	1352*	83.6*	24.16	387	2.80*	0.310*
Neutral Red	82*(65)	17.20	20.50	1.013	1412	90.6	25.20	400*	2.60*	0.306*
Gentian violet	92(77)	15.37	21.00	0.847*	1427	48.3*	7.60*	402*	2.50*	0.290*
Methylene Blue	95(82)	16.63	21.80	0.950*	1592	54.6*	10.26*	391	2.90	0.320
Crystal violet	96(83)	17.63	21.40	0.863*	1699	94.3	27.33	387	2.80*	0.310*
Congo red	96(83)	14.60	17.93*	0.987*	1411	93.3	31.00*	388	2.90	0.310*
Fast green	90(75)	13.67*	22.83	0.660*	1241*	94.3	26.36	388	2.90	0.320
Bromocresol purple	95(82)	15.37	19.03	0.943*	1471	94.0	24.96	387	2.90	0.320
Phenol Red	92(77)	13.27*	15.73*	1.137	1228*	95.0	26.00	404*	2.43*	0.290*
Nigrosine	89(70)	15.07	17.60*	0.677*	1341*	95.0	25.70	387	2.90	0.320
Erichro black-T	97(84)	15.53	23.20	0.830*	1512	95.6	31.20*	408*	2.40*	0.280*
Mureoxide (Amm.pur)	87(69)	16.40	22.27	0.563*	1438	92.0	29.16	387	2.80*	0.310*
Bromocresol green	94(78)	16.10	21.17	0.690*	1512	97.0	30.23*	388	2.90	0.320
Malachite green	97(84)	15.20	23.13	0.907*	1482	90.0	28.40	387	2.90	0.300*
Methyl Red	88(73)	14.97	19.17	0.847*	1336*	94.0	25.40	410*	2.30*	0.270*
Methyl Orange	97(84)	16.97	23.93	0.890*	1647	95.6	27.56	409*	2.40*	0.290*
Titan yellow	97(84)	16.20	24.53	0.943*	1577	92.0	23.46	390*	2.80*	0.320
Indigo caramine	94(79)	15.57	22.90	0.880*	1476	96.0	26.76	388	2.80*	0.320
Natural dye-kumkum	77(62)	19.33*	19.50	0.997*	1499	86.6*	24.33	412*	2.10*	0.270*
Natural dye-yellow	91(75)	14.57	21.07	0.957*	1331*	88.3	25.03	412*	2.20*	0.260*
Natural dye-pink	81*(68)	12.63*	15.90*	0.957*	1035*	90.0	21.90	410*	2.10*	0.270*
Natural dye-blue	88(73)	15.47	19.83	1.077	1363*	71.66*	14.76*	409*	2.03*	0.260*
Natural dye-brickred	95(82)	14.23*	21.77	1.107	1363*	80.0*	20.70*	410*	2.20*	0.270*
Control	98(85)	16.90	22.0	1.227	1661	95.0	25.56	385	3.00	0.330
S.Ed±	5.14	1.11	1.88	0.10	139.98	3.63	1.82	2.44	0.08	0.00
C.D (0.05)*	10.69	2.32	3.92	0.22	291.16	7.32	3.80	4.91	0.16	0.01

#Figures in parentheses are arcsihe transformed values.

most deleterious in relation to their effect on seed quality. The dyes namely Rhodamine-B, Titan yellow, Crystal violet and Methyl orange are the best and most favoured dyes in view of their promoting effect on seed quality in bengalgram. The most deleterious dyes in bengalgram were identified as natural dyes Pink, Kumkum and Blue; others were in mid range in terms of the fact that they were not very deleterious, but they certainly reduced the total seed quality components significantly when compared to the most favoured dyes as listed above.

Based on vibrant colours, shine, hues and uniform colouration imparted on seeds, as compiled from the survey of seed growers, processors and seed industry people, out of total sample of 100, we could bring out the most favoured seed colouring dyes out of the best dyes already enlisted on the basis of visual colour index as Rhodamine-B, Fuchsine and Titan yellow for redgram, Rhodamine-B, Fuchsine and Phenol red for blackgram and Rhodamine-B, Crystal violet and Titan yellow for bengalgram. Rhodamine-B, Crystal violet, Titan yellow in order of preference.

These influences as observed in present investigations are in line with earlier findings of Tonapi [2], Saraswathi [13] and Tonapi and Karivaratharaju [3].

The quantity of the dye required at 0.75 per cent concentration (prepared by dissolving 0.25 g of dye in 16.50ml water plus 15.0ml of ethylene glycol) varies with the individual dyes used in seed colouring and kind of seed to which the colour is to be imparted. Several dyes have been approved by department of agriculture in Canada and United States of America, viz., Rhodamine-B, Tartrazine, FD and C blue, Methylene blue, Methyl violet 2B, D and C red, D and C violet, D and C green and pigment red, based on their non-toxic nature in regard to seed germinability [14].

However, the promotory effect of some of the dyes may be due to the probable stimulatory effect on enzymes like α-amylase and dehydrogenase activity and their release during seed germination, because of which the faster rate of growth of seedlings becomes evident, as seen in the present study; in the form of higher root length, shoot length, and maximum dry weight of seedlings, including vigour index. The inhibitory toxic effect of Natural dyes Kumkum, Blue, Pink, Yellow, Brick red and Methyl red indicated the entry of the dye, though in very small quantity, into the seed, due to which probably the active chemical ingredient groups of each of these deleterious dyes might have interfered with seed energetics, enzyme release and macromolecule degradation in seed during seed germination to result in the form of maximum number of abnormal seedlings, lower vigour and decreased performance under stress conditions as evaluated through exhaustion test.

Through this study on colour standards, we would like to propose for efforts to standardize reproducible colour standards for crops as in USA, Canada and Europe. We propose that this provision can also be incorporated under the regulations of seed quality and pest control act after suitable modifications with the text that "Where the physical properties of the control product are such that the presence of the control product may not be recognized when used and is likely to expose a person or domestic animal to severe health risk, the control product shall therefore be denaturized by means of colour, odour or such other means as the central seed committee may approve to provide a signal or warning as to its presence". Where the seed is packaged, the package should bear a label with words " the seed is treated and colored with" followed by the name of the control measure product and the seed coloring dye, including the common name or chemical name of its active ingredient together with appropriate precautionary symbol and signal or warning words as the seed testing committee approves. If the treated-colored seed is sold and shipped in bulk, the shipping documents should bear information setting forth the common name or chemical name of active ingredient of both chemical and the seed coloring dye with a sub note that "seed coloring dye used is not injurious to seed". This will enable seed industry to adopt individual colors as their trademark including propriety coloring of parental lines to identify their seeds and seed coloring may substantially aid in preventing accidental usage of treated seeds as food or feed, or may help in upgrading the visual quality of blonded (discolored and rain soaked) and blended seeds (but, still maintaining seed germination at (75%) and above certification standards under emergent situations where there is a scarcity of seeds.

REFERENCE

1. ANONYMOUS (1967). Trade memorandums in relation to colour standards in Canada and United States of America.

2. TONAPI, V.A. (1988). Studies on the effect of harvesting conditions on seed yield, quality and storability of sorghum genotypes *(Sorghum bicolor* (L.) Moench). Ph.D Thesis submitted to Tamil Nadu Agricultural University, Coimbatore-641003, Tamil Nadu, India.

3. TONAPI, V.A. & T.V. KARIVARATHARAJU (1994). Studies on seed colouring in sorghum genotypes (*Sorghum bicolor* (L.) Moench). *Seed Tech. News*, **24**(4): 116.

4. VIVEKANANDAN, R. (1997). New approaches in colouring of crop seeds. MSc (Ag.) thesis submitted to Tamil Nadu Agricultural University, Coimbatore, India.

5. BASAVARAJ, G & M.B. KURDIKERI (1999). Effect of seed colouring on field performance in soybean. *Seed Res.*, **27**(2): 207.

6. ANONYMOUS (1985). International rules for seed testing. *Seed Sci. & Technol.*, **13**(2): 307-355.

7. ABDUL BAKI & J.D. ANDERSON (1973). Vigour determination in soybean seed by multiple criteria. *Crop Sci.*, **13**: 630-633.

8. PRESLEY, J.J. (1958). Relation of protoplast permeability in cotton seed viability and predisposition to seedling disease. *Plant Disease Reporter*, **42**(7): 852.

9. VANDERLIP, R.L., P.E. MOCKEL & JAN HALIM. (1973). Evaluation of vigour tests for sorghum seed. *Agronomy J.*, **65**: 486-488.

10. LAD, S.K (1986). Effects of different osmotic media of manitol and polyethylene glycol-4000 on germination and early seedling growth of sorghum variety M-35-1. *Sorghum News letter*, **29**: 90.

11. SIMPSON J.D. & J.M. NAYLOR (1962). Dormancy studies in seeds *of Avena fatua*, a relationship between maltose, amylases and gibberellins. *Canadian J. Bot.*, p. 50.

12. KITTOCK, D.L. & A.G. LAW (1968). Relationship of seedling vigour to respiration and tetrazolium chloride reduction by germinating wheat seeds. *Agronomy J.*, **60**: 286-288.

13. SARASWATHI, G. (1994). Studies on seed pelleting in relation to sowing qualities of cotton cv. LRA 5166. MSc. (Ag.) Thesis Tamil Nadu Agricultural University, Coimbatore, India.

14. ANONYMOUS (1979). Dupont de Nermours and Company, Welmingdon, Delware 19898, Chemicals, dyes and pigments (Personal Communication to dt 19.3.1979 Dr. K R Ramasamy, Dean (agriculture), Tamil Nadu Agricultural University, Coimbatore, TN 641003, India).