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Effect of Seed size and seed coat colour on Seed quality and productivity of red gram (*Cajanus cajan* L.)

V. KARIVARATHARAJU V. RAMAKRISHNAN, K. K. VADIVELU AND K. R. RAMASWAY

Seeds of red gram C. V. CO 1 varied in size and colour within wide limits. Three size of seeds viz., 5x5 6x6 retained and 6x8 posed occured in the seed lot. Besides sizes variation, seed coat colour varition also was encountered in one and the same sample of seeds. Seeds possessing seed coat of uniformly tan colour uniformly dark tan colour and dark tan colour with black patches occurred Nearly 78 50 percant seeds could be recovered by processing withExtwire mesh sieve wich included 56 6 per cent off coloured seedsAbout 10 64 per cent seeds out of 16.15 percent in 5×5 retained seeds possessed dark tan with black patches The vigour rating on the basis of stress test such as brick grit test, rate of water absorption, electrical conductivity had clearly indicated the physiological stamina viz. high degree of physiolpgical activity possessed by large-sized and healthy seeds. All the vigour tests confirmed the superiority of large sized. dark tan as well as tan coloured seeds over small sized and off coloured seeds. Croup growth, seed production potential, root growth and nodule formation were maximum for the large sized seeds Flowering advanced by 8.11 days in plants from large-sized seeds when compared to those from the small-sized seeds similarly the pod production.

Off-coloured seeds viz, dark- tan with black patches were found to carry 80 per cent of *Rhizoctonia solani* infection white initormly dark tan seeds carried 70 per cent *Alternaria* sp and 30 per cent *Rhizoctonia solani* infection. Studies revealed that seeds graded using 6×6 wire mesh sieveor its eqcivalent round perforated sieve and free from off-coloured seeds should be used for maximising seed production

The relation between size of seed and germination or between seed size and the rate of growth, ultimate size of mature plants and their yield performance have been reported by a few workers (Cummings, 1914; Schmidt, 1924; Kotowaski. 1928; Erickson, 1946: Rogler 1954; Kaufman and McFadden, 1963, Cope, 1966; Harper and Obeid, 1967: Gelmond. 1971; Sivasubramaniam and Ramakrishnan, 1972: Srivastava and Nigam 1973). The effect of seed coat colour on these aspects had, however, received very little attention. Changes in seed coat colour during deterioration either due to ageing or damage by heat or fungi during storage were comprehensively reported in seeds of limabean. clover and alfalfa (Abdul-Baki and Anderson, 1971). The influence of seed size on one or several of growth attributes and seed production potential reported had not been the same; in some, large-sized seeds were observed to be superior in respect to geimination, plant vigour and yield to small-sized seeds of the same sample; in others, they were reported to confer plant vigour and growth only during early phases of croup growth.

In view of the conflicting reports on the effect of seed size on crop production and lack of information on the performance of normal coloured as well as off-coloured seeds from different size grades in red gram, the present study was initiated with the annual variety Co 1.

MATERIAL AND METHODS

Red gram seed of cv. Co 1 harvested in December-January 1973-74 were seperated with hand wire mesh sieves

into three size grades, viz., 1) seeds retained by B.S.S. 5 × 5 wire mesh sieve, 2) seeds retained by 6 × 6 wire mesh sieve and 3) seeds that passed through 6 × 6 wire meshs sieve. The seeds from bulk sample retained by 5 × 5 wire mesh sieve were further separated into three colour categories namely, uniformly tan (C1), uniformly dark tan (C2), dark tan with black patches (C3), and were compared with the ungraded Bulk (B) (consisting of the above three colour categories).

The moisture content of seeds of both size and colour categories was 9 per cent. These were subjected to standard germination test (International Rules for Seed Testing, 1966), brick-grit test (Lindenbein and Bault, 1955 and Fritz, 1965). Observations on 1000-seed weight, seed recovery percentage and the percentage of occurrence of off-coloured seeds in 5 × 5 retained fraction were recorded. Further, observations on germination, rate of field emergence root and shoot length were recorded. Data on growth characters such as plant height, branching intensity, root length, nodule weight, number of leaves, flowres and pods produced per plant besides pod length and breath, and fresh and dry weights of plants were recorded in respect to plants obtained from seeds of different sizes sown on 4-1-74 under field conditions using split plot design with plot size of 5 × 3m replicated three times.

Seed vigour tests namely, electrical conductivity and acidity of the leachate from the seeds of the colour categories were carried out. The rate of water absorption by seeds in each of the colour categories was also assessed by soaking fifty seeds in 10 ml of water for 3 hours. Tetrazoloum testing and seed health testing were also carried out with these seeds.

To test the membrane leakage, 50 seeds were soaked in 50 ml water for 16 hrs, and the conductivity of the leachate was measured using Elico-conductivity bridge. Acidity of the leachate was assessed, using 'Biochem' pH meter. Sugar was estimated by the Somogyi (1952) method from 1 ml of the leachate. Off-colour sensitivity was assessed by exposing the seeds to gamma irradiation (22 Kr) and subjecting to field emergence test.

RESULTS AND DISCUSSION

Seeds graded sizewise showed a progressive increase in seed weight with increase in seed size. A maximum recovery of about 78.50 percent was obtained from the 6 X 6 retained fraction, while in 5 X 5 retained and 6 X 6 passed fractions it was only 16.15 and 5.37 percent, respectively. Germination percentage recorded was fairly high from seeds of the two top grades alone. The last grade recorded the lowest germination value. Evidently, the top grades possessed the maximum field emergence potential.

The growth characters of the plants from large-sized seeds registered higher values for all the characters studied than those grown form 6 x 6 passed seeds. In general measurements on shoot length indicated almost negligi-

ble difference. However, the marked differences in root growth behaviour evidently proved the superior qualitiy of the seeds from the top two grades; root/shoot ratios were also higher for these grades.

Vigour test namely, brick grit test also indicated the inferiority of last grade seeds that were unable to withstand the stress leading to considerable reduction in germination.

Plant height was more or less uniform for plants from two grades, while it was very low for those from the last grade seeds. Profuse branching occurred only in plants from seeds of first two grades, while it was characteristically low in plants from the seeds, of last grade. Total number of leaves increased two to three folds in plants from seeds of two top grades, Number of flowers produced was the minimum from plants from 5x5 and 6x6 retained seeds. Flowering was advanced by 8-11 days in plants from the two superior grade seeds.

When the crop was 87 day-old, only the plants grown from 5x5 and 6 X 6 retained fractions possessed, on an average, 18 and 8 pods, with the mean pod-length and breadth in plants of 3.5X0.5 cmand3 0X0.5 cm, respectively. Plants from the top two grades possessed root nodule weights of 0 75 and 0.61 g, as against 0.38 g possessed by plants raised from 6X6 passed seeds.

Fresh and dry weight recorded on 87th day showed (i) nearly three-to five-fold increases; (ii) root-weight was similarly high by two to three times; and (iii) the root/shoot ratio increased to four to six times in plants from the top grades, when compared to the plants from 6 X 6 passed seeds: Since a plant with deep, extensive and efficient root system is preferable in rainfed areas, the lowest grade seed looses it value.

The superior growth performance conferred by the initial seed vigour possessed by the seeds from the two top grades was maintained throuhout the crop growth period of 87 days studied. In red gram, as observed in flax by Harper and Obeid 1967), large seeds produced taller plants and more dry matter per plant. Quality attributes possessed by large seeds in this crop as revealed by the present study, had amply demonstrated the potential role that grading of seeds could play in augmenting the production even under optimum plant population was contradictory to the report of Harper and Obeid (1967).

Effect of seed coat colour

Majority of the off-colour seeds amounting to 56.6 per cent occurred in 6 X 6 retained fraction while 0.90 per cent occurred 6 X 6 passed fraction: Thus, from the data of July raised crop, it was evident that 68.14 per cent seeds in the sampled lot were off-coloured.

In the seed sample investigated, 5 X 5 retained seeds constituted 16.50 per cent and out of this 10.64 per cent seeds possessed seed cost of dark tan colour with black patches:

The rest comprised of seeds of two seed cost colour categories namely, uniformly tan and uniformly dark tan. The results of testing the seeds belonging to the three seed coat colour categories furnished in Table 3, clearly revealed the adverse effect of the presence of black patches on dark tan seed coat, on the viability of seeds.

Quality assessment of off-coloured seeds from different sizes is given in (Table 1) It became increasingly clear that large-sized and uniformly tan coloured seeds possessed a high degree of physiological stamina, Both the small-sized (6 X 6 passed). and off-coloured seeds recorded not only low germination but also increased the percentage of dead seeds. Rate of water absorption, increased electrical conductivity and more acidic nature of the seed steep water showed a positive relationship to the off-coloured seed coat. The off-coloured seeds had not only lowered the germination percentage, but also increased the number of dead seeds up to 59 percent. It is plausible that changes in seed coat colour in legumes may be indicative of ageing and deterioration and was associated with viability.

Measurements of electrical conductivity showed a relationship with the intensity of seed colour, the conductivity being higher in the third colour category than in the first two. The aqueous extract of seeds from the third colour category wes also more acidic than those of the other colour categories.

The rate of water absorption by the seeds of dark tan with black patches showed a rise of 55.3 percent in 3 hr, while it was nearly half for the first two colour grades. In terms of water absorption, the germination percentages were found to be high for the uniformly tan coloured seeds. This was test verified with tetrazolium testing. A highly significant correlation was obtained for these. Moreover, colour category-1 consisted of 15 per cent hard seeds, while the other colour categories comprised only dead seeds to the extent of 4 and 45 percent; respectively. This has clearly proved that off-colour seeds usually heve low respiration rates (Abdul Baki and Anderson, 1971). Irrespective of the seed sizes, seeds that are uniformly dark tan with black patches possessed lower root and shoot lengths. Field emergence as well as field stand also were reduced by these seeds. Water stress test also indicated the coloured categories to be more susceptible to mortality. Further, the off-coloured seeds never showed visible expression of the growth.

The off-coloured seeds usually have been shown to be highly sensitive to gamma irradiation. In the present studies too, when these seeds irrespective. of of the seed sizes were exposed to 22kr gamma irradiation. the production of abnormal seedling markedly decreased. Of all the "types," of seed, uniformly tan coloured seed produced 51 to 66 per

cent normal seedlings. The seed health testing of those with blemished seed coat had surprisingly revealed the close relationship of black patches with the seed-borne pathogens. It was found that seventy per cent of the dark-tan coloured seeds were infected by *Alter naria* sd, while the remaining 30 per cent were affected by *Rhizoctonia solani*. Among the dark-tan coloured seeds with black patches 80 per cent were infected only by *Rhizoctonia solani*. Harrington and Doughlas (1970) also reported that the seeds invaded by pathogens before harvest usually showed discolouration, shrivelling, reduced germination and/or reduced yields, because of infection of plants through the seed.

The adverse effect of discolouration of seeds on seed viability and vigour was incredibly large, the effect incresing with the increasing intensity of discolouration in proporation to the parasitization of the seed by pathogens as revealed by tetrazolium staining pattern (Table 2). low field emergence, field stand, and dry matter production (Table 3) and seed yield (Table 4). The differences due to colour and size veriations were highly significant. The crop raised with 5×5 retained C1 seed yielded 40 per cent more seed than that of a crop grown with ungraded bulk seed had yielded. By planting dark-tan seeds with black patches, the yield of seed was decreased dy 20 per cent. The result has increasingly made clear that seeds retained by 6x6 wire mesh sieve or its equivalent round preforated sieve and possessing only the uniformly tan and/or dark tan-coloured seed coat should be used for securing maximum field stand and high yield (Table 6).

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TABLE 1. Effect of seed and colour categories on selected parameters of vigour

Parameters	6×5 retained				6×6 retained				6×6 passed			
	Ungrated	C1	C2	C3	Ungrated	C1	C2	C3	Ungrated	C1	C2	C3
1000-Seed weight in (g)	86.70	85.00	89.00	65 20	72,90	75.00	70.70	73.00	47.90	49.00	50.00	43.70
Electrical conductivity (umhos/cm)	648.00	420.00	466.00	691.00	534.00	339.00	318.00	625.00	34.00	439.00	426.00	666.00
pH	6.20	6,40	6,30	6.00	6.50	6.00	6.11	6.00	6,30	6,90	6.30	6.20
Sugar exudation glucose, CD	1.00	1.00	1.50	1.20	1.25	0.80	1.50	0.80	0.85	0,85	0,65	0.80
Water absorption (%)	—	26.50	29,20	55 30	—	14,60	23.00	50,70	—	38.70	40.00	55.60
Standard germination test												
germination (%)	79.00	87.00	74.00	40,00	70.00	80.00	74.00	54.00	60 00	80.00	70.00	33 00
Shoot length (cm)	22.10	23.70	23·00	21.60	19.10	23.20	21.60	18,50	18.80	19.40	19.40	15.80
Root length (cm)	8,40	10.20	6.90	4.00	6.50	6.50	4.80	6.20	5.40	8.50	7.40	4.80
Brick-grit test												
Germination (%)	42.00	62 00	40.00	24·00	56,00	80 00	80.00	18 00	57.00	62.00	72.00	42.00
Shoot length (cm)	9,50	13 20	13.90	8.20	9.20	14.00	11.30	12.00	4·00	7.20	6.50	5.50
Root length (cm)	3.60	4.60	5 70	3.00	3.60	6.10	4.80	4.50	1.71	3.40	2.50	2.40
Water stress test Survial (%)	49.00	52.00	46 00	Nil	61.00	68.00	54.00	Nil	Nil	Nil	Nil	Nil

Table 2. Tetrazolium staining pattern germinable and non germinable seeds(%) of different colour category in red gram seeds C. V. Co 1

Tetrazolium staining	Uniformly tan			Uniformly dark tan			Dark tan with black patches		
	a*	b*	c*	a	b	c	a	b	c
Germinable-Seed completely stained	34	60	40	30	50	44	8	10	24
Germinable-Minor unstained areas on cotyledons	28	20	22	10	30	28	16	8	18
Non-germinable-More than extreme tip of radicle unstained	4	–	–	–	18	–	4	8	–
Non-germinable: Juncture of radicle-hypocotyl axis and cotyledons unstained	4	–	–	4	–	–	6	–	–
Non-germinable: More than one half of upperend and of cotyledons unstained	–	12	–	–	–	8	–	14	–
-do-milky red areas of cotyledons	16	–	–	–	–	–	16	–	–
Non-germinable, seed stained purplish red; stain extends through entire cross sectional area of cotyledons	14	–	30	56	–	12	50	52	32
Hard (H) seed / Dead seed (D)	8 (H)	2 (H)		2 (H)	4 (D)	–	8 (D)	26 (D)	

a = 5 x 5 wire mesh; b = 6 x 6 wire mesh retained and
*c = 6 x 6 wire mesh passed seeds

TABLE 3 Effect of seed size and colour categories on yield attributing characters at the age of one month

Seeds retained by wiremesh size	Plant height (cm)	Root length (cm)	No of leaves	Fresh wt. (g)/ plant	Dry wt. (g)/ plant	Root dry wt. (g)/ plant
6 × 6: Retained						
Uniformly tan (C1)	30.15	9.70	10.20	3 20	0.73	0.085
Uniformly dark tan (C2)	30 25	7 90	10.40	3.15	0.72	0.055
Uniformly dark tan with black patches (C3)	20,05	7,80	10.00	1 97	0.53	0.035
Ungraded bulk (B)	25.80	8.75	9.40	1.95	0.50	0.050
6 × 6: Retained						
Uniformly tan (C1)	26.75	9.15	9.60	2.60	0 59	0.075
Uniformly dark tan (C2)	24.60	9 45	8.00	2.15	0,52	0 070
Uniformly dark tan with black patches (C3)	20,08	6.90	7.90	1.50	0.37	0 065
Ungraded bulk (B)	21.45	8.91	8.15	1.60	0.40	0.047
6 × 6 Passed						
Uniformly tan (C1)	20.76	7.16	7.50	1.35	0.30	0,050
Uniformly dark tan (C2)	17.35	6.23	6.60	1.05	0.25	0.048
Uniformly dark tan with black patches (C3)	13.10	5.90	6 00	0.56	0.70	0.018
Ungraded bulk (B)	16.89	6.77	6.90	0.75	0.20	0 045

Table 4. Effect of seed size and colour variation on final yield

Treatments Retained (R) by wire mesh sieve	Colour	Seed yiled (kg/acre)
5 x 5 R	C_1	1221.7
5 x 5 R	C_2	923.6
5 x 5 R	C_3	709.4
5 x 5 R Bulk	B	876.8
6 x 6 R	C_1	995.5
6 x 6 R	C_2	656.3
6 x 6 R	C_3	600.2
6 x 6 R Bulk	B	919.1
6 x 6 Passed (P)	C_1	862.7
6 x 6 P	C_2	839.8
6 x 6 P	C_3	378.8
6 x 6 P Bulk	B	474.2
SE d (P=0.05) 37.3	43.1	74.7
C.D. 109.4	126.4	219.07