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Effect of specific gravity separation on seed germination and biochemical potential of castor hybrid YRCH1

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Abstract
An attempt was made to study the effect of specific gravity separation on seed germination and biochemical potential of castor hybrid YRCH 1 at AEC & RI, TNAU, Kumulur. The seeds were graded in a specific gravity separator *viz.*, vertical height (cm), horizontal height (cm) and air blow rate (m^3/hr) adjustments of 1, 0 and 7 respectively at 450 rpm. The seeds were upgraded into five grades viz; first to fifth designated as A, B, C, D, and E respectively (first grade represents low weight seeds and fifth grade represents high weight seeds). After grading, the seeds were subjected to for the following parameters viz; seed recovery percentage, 100 seed weight, seed filling percentage, germination percentage, speed of germination, seedling length (cm), dry matter production (g/10 seedlings), vigour index, field emergence per cent and bio chemical properties. The results revealed that higher germination per cent was recorded in the E grade (92 per cent) than A, B, C and D grades as well as F-ungraded bulk seeds. The estimation of storage reserves revealed that the variation existed among the grades separated by the specific gravity separator. The E grade seeds recorded higher protein, oil and carbohydrate contents, which was substantiated the higher germination, vigour and field emergence recorded by this grade of seeds.

Keywords: Castor, gravity separator, seed, germination, seedling vigour

Introduction
Castor (*Ricinus communis* L.) is a fast growing C_3 plant of indeterminate type, native of tropical Africa. It is an important member of Euphorbiaceae family. Among the nine cultivated oilseed crops, castor is the most important non - edible industrial oilseed crop grown across the world in tropical, sub-tropical and warm temperate region. It has great industrial and commercial value. Castor oil has multivarious applications in production of wide industrial products ranging from medicines, aviation fuels, fuel additives, biopolymers and biodiesel. Gujarat is leading state in castor production in the country with 0.8 M ha cultivated area, which is about 60% of total castor area of India and total production of 1.7 ton, which is about 80% of total castor production of India. Castor oil is of much industrial use. India is a leading exporting country of castor oil and its derivatives to be worth of more than Rs. 4000 crore. The second green revolution is expected to emerge from rainfed or dryland agriculture system where oilseeds and pulses are important components. In India, castor has gained commercial significance as the country is the pioneer in development and cultivation of hybrids both under irrigated and rainfed situations.

Non-availability of quality seeds is one of the major constraints in increasing the productivity of all the agricultural crops. Seeds are graded based on size as a component under post-harvest seed handling technique, but researchers on sunflower (Balamurugan, 1993) [6], moringa (Sivasubramanian, 1996) [24], cotton (Jayashree, 1996) [11] and bhendi (Vijayakumar, 1996) [28] opined that grading seeds based on their weight was better than size grading due to the genetic accommodation of embryo inside the seed coat. Castor is one such euphorbiaceous crop where a space exists between seed coat and embryo with endosperm. Kulkarni (1959) [14] reported the presence of air cavities in castor seed. Specific gravity separator stratifies the seed grades based on the weight of individual seeds, so as to separate the filled seeds from the empty seeds. Specific gravity separation has been utilized to separate the Eucalyptus seeds (Dharmalingam *et al*. 1973, Khan 1976) [9, 12], *Casuarina equisetifolia* seeds (Umarani and Vanangamudi, 2002) [26] with higher weight and to increase seed germination percentage. Protein, carbohydrate and lipids constitute the bulk of the storage reserves in seeds (Bewley and Black 1983) [7]. Mobilization of these reserves occurs during germination and the early stages of seedling growth. The breakdown products are used by developing seedlings as a nutritive source (Anderson and Abdul-Baki 1971) [2].

Hence, in this present study, seeds of castor hybrid YRCH1 were separated into five grades using a specific gravity separator. The specific gravity separator worked on the principle of floatation in air to stratify and separate seeds according to the specific gravity of seeds. The grades thus separated, were analyzed for differences in seed viability and vigour. The protein, carbohydrate, and oil content were tested to understand the basis of differences in seed germination.

Materials and Methods

The seeds were collected from Tapioca and Castor Research Station, Yethapur and subjected to specific gravity separator at 440, 450 and 460 rpm. In order to identify the appropriate machine settings, the vertical height (0, 0.5, and 1cm), horizontal height (0, 0.5, and 1cm) and air blow rate (6, 7 and 8m^3/hr) adjustments were tried in all possible combinations. The seeds were divided into different grade viz, A, B, C, D, and E respectively (first grade represents low weight seeds and fifth grade represents high weight seeds). The ungraded bulk seeds denoted as F grade. After grading, the seeds were evaluated for the following observations such as seed recovery percentage, 100 seed weight, seed filling percentage, germination percentage, speed of germination, seedling length(cm), dry matter production (g/10 seedlings), vigour index and field emergence per cent and bio chemical parameters.

Seed physiological and biochemical parameters

Four hundred seeds of each grade were used for conducting germination test in sand method with four replications. Daily seedling emergence was recorded from first count day (7^{th} day) onwards until final count day (14^{th} day), for calculation of speed of germination. The germination percentage, recorded as seeds that produced normal seedlings, was determined after 14^{th} day of sowing (ISTA 2014). After germination count, 10 random seedlings were measured for their root and shoot lengths and vigour index I (germination (%) X seedling length (cm)) and vigour index II (germination (%) x seedling dry weight (g/10 seedlings)) (Abdul-Baki & Anderson 1973) [1]. The following seed biochemical parameters like protein (Lowry's method by Peterson 1977) [20], carbohydrates (phenol sulphuric acid method by Taylor 1995) [25] and oil (soxhlet method by Natarajan *et al*., 2003) [17] were analyzed.

The experiment was conducted in a Completely Randomized Block Design (CRD). The results were subjected to analysis of variance and tested (t-test) for significant difference (p=0.05) as suggested by Panse and Sukhatme (1999) [18]. Percentage values were transformed into arc sine values prior to statistical analysis.

Results and Discussion

In this study, a castor seed was upgraded using specific gravity separator with different combinations of machine settings. In order to identify the appropriate machine settings, the vertical height (0, 0.5, and 1cm), horizontal height (0, 0.5, and 1 cm) and air blow rate (6, 7 and 8 m^3/hr) adjustments were tried in all possible combinations. After standardization, selected three combinations only tabulated for comparison. All the five grades of seeds in each machine setting were differed significantly for seed recovery percentage, 100 seed weight and seed filling percentage (Table 1). The E grade seeds recorded the highest seed recovery (48%), with a 100 seed weight of 32.00 g and 100% seed filling. The A, B, C, D and F recorded 0.93, 1.53, 11.23 and 37% of seed recovery corresponding to 15.50, 21.46, 27.45, 29.98 and 28.59 g of seed weight respectively. Regarding seed filling percentage of A, B, C, D and bulk seeds recorded 33.50, 49.25, 75.00, 88.00, and 90% respectively (Table 1). The percentage of seed germination recorded by E grade seeds was 92 per cent. This value was higher than the A, B, C, D and ungraded bulk F seeds (34, 30, 13, 9 and 6% respectively). The root length, shoot length, dry matter production, vigour index I, vigour index II and field emergence percentage were also followed the same trend as that of germination value recorded for all the five grade of seeds (Table 1 & Fig.1).

Among the biochemical analysis the significant influence was exist in oil content (per cent) among the seed grades. The oil content was more in E grade (51.44%) followed by D grade (49.03%). Whereas oil content of 38.33 per cent was recorded by A grade seeds. However, the oil content of bulk seed was 17.40 per cent. Significant difference was observed for protein content among the 5 grade in protein was obtained among the seed grade. The protein content recorded by E grade was higher (23.20%) than other grade seeds. It was lower (19.50%) in A grade seeds. The carbohydrate content varied from 9.76 per cent (E grade seeds) to 5.97 per cent (A grade seeds). However, the carbohydrate content of bulk seeds was 7.67 per cent (Table 1).The machine setting on (0.5 cm, 0 cm, 6 m3/hr,440 rpm), and (1.5 cm, 0 cm, 8 m3/hr,460 rpm) separate the seeds to five grades but not properly grade the seeds. The physical, physiological and biochemical parameter observation recorded that this value not higher than machine setting on (1cm, 0cm, 7 m3/hr, 450 rpm). (Table 2&3 and fig 2&3).

The data obtained in the present study showed that protein and oil content decreased as quality of seed decreased. However, the inverse trend was noticed for carbohydrate and reducing sugar contents. The observation of the filling percentages showed that as the corresponding seed quality decreasing trend. The superiority of the E grade seeds with reference to seed filling, hundred seed weight, protein and oil contents, was recorded positively in the germination and seedling vigour. Several authors have recorded their experience on the positive influence of upgrading the seed quality on the subsequent seed germination and seedling vigour. But heavy and medium fraction recorded higher germination than even bulk, exhibiting enhanced seed quality through specific gravity grading. Anon (1996) [5] in sunflower and soybean and Patil and Sarode (1998) [19] in wheat and saraswathi (1995) [21] cotton obtained similar effective association between seed weight and germination. The oil content of specific gravity seed fraction also expressed an influensive association with seed weight in line with result of Balamurugan (1993) [6] in sunflower. The higher germination percentage in high density seeds might be due to well-developed embryo and good filling of seeds and the efficient utilization of large food reserves for production of energy that expressed through seedling vigour (McDaniel, 1969) [16].

Table 1: Effect of specific gravity of seed on physical, physiological and bio chemical parameters of castor hybrid YRCH1 (Setting value -1 cm, 0 cm, 7 m^3/hr, 450 rpm).

Treatments (specific gravity class)	Seed recovery (%)	100 seed weight (g)	Seed filling (%)	Germination (%)	Speed of germination	Root length (cm)	Shoot length (cm)	Dry matter production (g/10 seedlings)	Vigour Index I	Vigour Index II	Field Emergence (%)	Oil (%)	Protein (%)	Carbohydrates (%)
A-First grade	0.93 (5.50)	15.50	33.50 (35.36)	58 (49.32)	2.80	10.90	27.26	1.27	2194.17	73.15	50 (45.00)	38.33 (38.25)	19.50 (26.20)	5.973 (14.15)
B-Second grade	1.53 (7.02)	21.46	49.25 (44.57)	62 (51.95)	3.00	12.48	29.28	1.47	2588.34	90.82	55 (47.88)	41.23 (39.95)	21.43 (27.58)	6.853 (15.16)
C-Third grade	11.23 (19.55)	27.45	75.00 (60.01)	79 (62.74)	3.50	14.25	33.39	1.79	3764.17	141.01	71 (57.43)	43.33 (41.17)	22.64 (28.40)	7.673 (16.08)
D-Fourth grade	37.53 (37.77)	29.98	88.00 (69.77)	83 (65.67)	4.83	14.42	34.01	1.98	4018.90	164.16	79 (62.74)	49.03 (44.45)	23.24 (28.82)	8.673 (17.13)
E-Fifth grade	48.80 (44.31)	32.00	100.00 (89.71)	92 (73.65)	5.08	15.17	35.00	2.56	4616.35	235.74	80 (63.45)	51.44 (45.83)	25.22 (30.14)	9.760 (18.20)
F-Bulk	-	28.59	90.00 (71.62)	86 (68.08)	4.00	13.14	31.95	1.81	3877.93	155.23	78 (61.71)	48.18 (43.96)	23.20 (28.79)	7.673 (16.08)
Mean	20.00 (22.83)	25.82	72.63 (61.84)	77 (61.89)	3.86	13.39	31.81	1.81	3509.97	143.35	69 (56.36)	45.26 (42.27)	19.50 (28.32)	7.768 (16.13)
SEd	0.658	0.554	0.909	0.938	0.145	0.325	0.495	1.27	73.165	3.377	1.030	0.619	0.560	0.339
CD(0.05)	1.402	1.164	1.910	1.971	0.304	0.683	1.041	1.47	153.717	7.095	2.165	1.350	1.220	0.738

(Figure in parentheses indicate arc sine transformed values)

Table 2: Effect of specific gravity of seed on physical, physiological and bio chemical parameters of castor hybrid YRCH1 (Setting value - 0.5 cm, 0cm, 6 m^3/hr, 440 rpm).

Treatments (specific gravity class)	Seed recovery (%)	100 seed weight (g)	Seed filling (%)	Germination (%)	Speed of germination	Root length (cm)	Shoot length (cm)	Dry matter production (g/10 seedlings)	Vigour Index I	Vigour Index II	Field Emergence (%)	Oil (%)	Protein (%)	Carbohydrates (%)
A-First grade	21.00 (27.26)	23.50	40 (39.23)	66 (54.34)	3.00	10.16	28.54	1.32	2554.82	86.95	55 (47.58)	40.00 (39.23)	20.29 (26.78)	6.307 (14.54)
B-Second grade	22.75 (28.48)	25.50	66 (54.49)	70 (56.80)	3.13	11.71	29.03	1.42	2850.51	99.05	68 (55.25)	42.33 (40.59)	20.85 (27.17)	6.683 (14.97)
C-Third grade	37.50 (37.76)	26.50	74 (59.35)	76 (60.68)	3.50	12.86	30.83	1.64	3319.42	124.23	74 (59.02)	44.00 (41.55)	21.31 (27.49)	7.223 (15.59)
D-Fourth grade	11.75 (20.01)	28.60	75 (60.05)	80 (63.45)	3.88	13.66	31.72	1.71	3632.60	136.77	77 (61.36)	46.00 (42.71)	22.67 (28.44)	7.820 (16.24)
E-Fifth grade	7.00 (15.25)	28.75	78 (61.73)	86 (68.08)	4.18	13.94	32.02	1.84	3951.23	157.85	79 (62.38)	49.00 (44.43)	24.60 (29.73)	8.860 (17.32)
F-Bulk	-	28.59	90.00 (71.62)	86 (68.08)	4.00	13.14	31.95	1.81	3877.93	155.23	78 (61.71)	48.18 (43.96)	23.20 (28.79)	7.673 (16.08)
Mean	20.00 (25.75)	26.9067	67 (57.74)	77 (61.90)	3.61	12.57	30.68	1.62	3364.41	126.67	71 (57.88)	44.92 (42.08)	22.15 (28.07)	7.43 (15.79)
SEd	1.006	0.850	1.252	1.044	0.141	0.569	0.602	0.041	86.929	3.019	0.758	0.448	0.350	0.343
CD(0.05)	2.146	1.786	2.631	2.193	0.297	1.195	1.266	0.086	182.634	6.344	1.594	0.976	0.763	0.748

(Figure in parentheses indicate arc sine transformed values)

Table 3: Effect of specific gravity of seed on physical, physiological and bio chemical parameters of castor hybrid YRCH1 (Setting value -1.5 cm, 0 cm, 8 m^3/hr, 460 rpm).

Treatments (specific gravity class)	Seed recovery (%)	100 seed weight (g)	Seed filling (%)	Germination (%)	Speed of germination	Root length (cm)	Shoot length (cm)	Dry matter production (g/10 seedlings)	Vigour Index I	Vigour Index II	Field Emergence (%)	Oil (%)	Protein (%)	Carbohydrates (%)
A-First grade	2.23 (8.54)	24.50	48 (43.71)	75 (59.86)	3.50	12.99	30.80	1.65	3271.42	123.55	63 (52.90)	41.00 (39.82)	21.20 (27.42)	6.63 (14.92)
B-Second grade	5.23 (13.15)	23.50	52 (45.86)	74 (59.20)	3.18	12.21	30.35	1.44	3138.39	106.41	62 (51.95)	43.00 (40.98)	22.10 (28.04)	6.98 (15.32)
C-Third grade	25.30 (30.19)	26.68	73 (58.54)	76 (60.68)	3.45	12.86	30.83	1.64	3321.29	125.38	68 (55.56)	44.67 (41.94)	22.47 (28.29)	7.22 (15.59)
D-Fourth grade	46.50 (42.99)	30.35	88 (69.76)	80 (63.28)	3.88	13.71	32.16	1.82	3659.04	144.98	74 (59.19)	47.00 (43.28)	24.11 (29.40)	8.51 (16.96)
E-Fifth grade	20.75 (27.08)	28.33	78 (61.90)	71 (57.27)	3.00	12.21	29.03	1.55	2918.64	109.50	59 (50.19)	46.00 (42.71)	22.77 (28.50)	7.65 (16.06)
F-Bulk	-	28.59	90.00 (71.62)	86 (68.08)	4.00	13.14	31.95	1.81	3877.93	155.23	78 (61.71)	48.18 (43.96)	23.20 (28.79)	7.67 (16.08)
Mean	20.00 (24.39)	26.99	71 (58.56)	(77) 61.39	3.50	12.85	30.85	1.65	3364.451	127.50	67 (55.17)	44.97 (42.11)	22.64 (28.40)	7.45 (15.82)
SEd	0.851	1.002	1.125	1.085	0.142	0.506	0.492	0.061	88.714	5.331	0.938	0.524	0.326	0.255
CD(0.05)	1.815	2.105	2.364	2.280	0.298	1.064	1.034	0.129	186.385	11.201	1.972	1.141	0.710	0.555

(Figure in parentheses indicate arc sine transformed values)

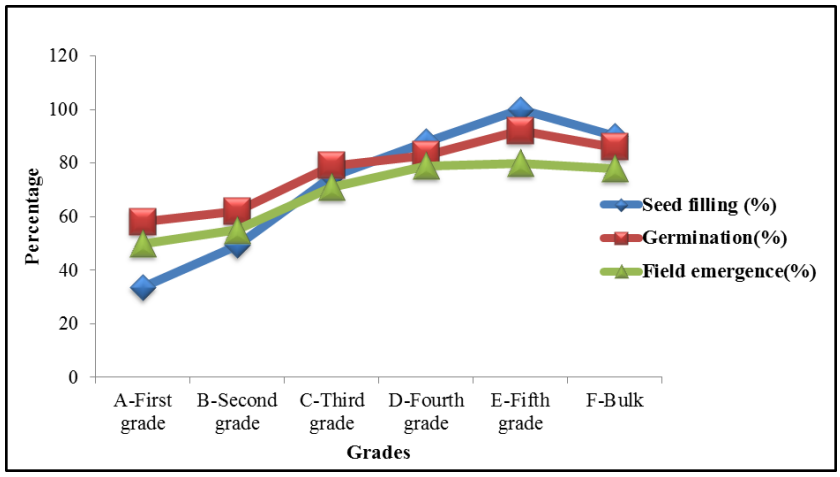

Fig 1: Effect of specific gravity of seeds on seed filling (%), germination (%) and field emergence (%) of castor hybrid YRCH1 (Setting value - 1 cm, 0 cm, 7 m^3/hr, 450 rpm).

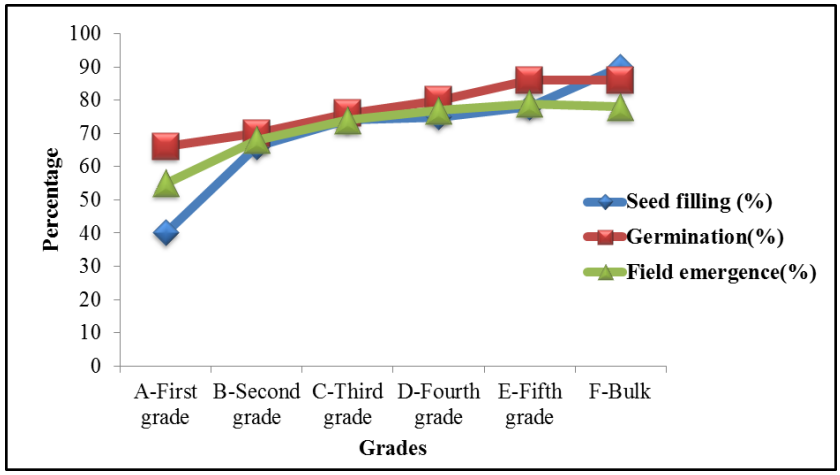

Fig 2: Effect of specific gravity of seeds on seed filling (%), germination (%) and field emergence (%) of castor hybrid YRCH1 (Setting value - 0.5 cm, 0cm, 6 m^3/hr, 440 rpm)

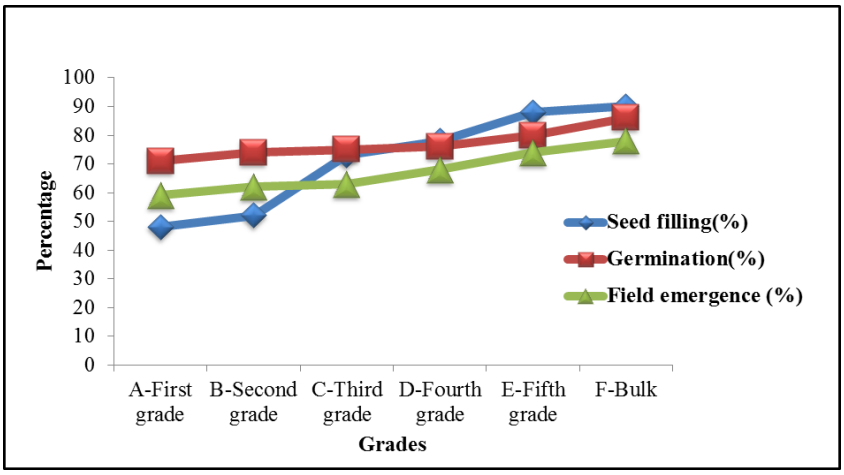

Fig 3: Effect of specific gravity of seeds on seed filling (%), germination (%) and field emergence (%) of castor hybrid YRCH1 (Setting value -1.5 cm, 0 cm, 8 m^3/hr, 460 rpm)

Conclusions

From this study it could be concluded that castor hybrid YRCH1 seed quality can be upgraded by using specific gravity separator with the following machine setting like vertical height-1 cm, horizontal height-0 cm, air blow rate -7 m3/hr and deck speed at 450rpm. Graded seeds of castor found to have higher physical, physiological and biochemical quality. As per the Indian Minimum Seed Certification Standard, the castor seed germination is 70 per cent only. Hence, it is concluded that germination recorded at E grade (92 per cent), D grade (83 per cent) and C grade (79 per cent) seeds. The entire three grade used for seed purpose.

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