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Short Communication

A comparative study of hybrid and inbred cultivars for germination and other related traits of pigeonpea

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ABSTRACT

Eleven pigeonpea hybrids and 4 inbred cultivars were evaluated to study seed germination and seedling growth parameters using 'Between Paper Towel' (BPT) method. The test was conducted over a period of 10 days at room temperature in a seed germinator. Data were recorded on test weight, germination, root length, shoot length, shoot to root ratio, seedling dry weight and seedling vigour index. Significant differences were observed among entries for all the traits studied. Significantly greater values for germination (99.5%), root length (11.6 cm), seedling vigour index (1832), seedling dry weight (4.7 g) and test weight (11.4 g) were recorded for hybrids compared to inbred lines. The presence of longer root in the hybrids resulted in producing lengthier roots and greater tolerance to drought during early growth stages. Thus, greater seedling vigour of the hybrids would also contribute to their higher plant vigour and seed yields.

Key words: Germination, Hybrids, Inbred cultivars, Pigeonpea, Seedling vigour index

Pigeonpea [*Cajanus cajan* (L.) Millsp.] is an important pulse crop predominantly grown in the tropics and subtropics for their high protein grains. It has been observed that despite increase in its area and production, the national mean yield of pigeonpea (774 kg/ha) has remained consistently low over the last five decades. To break this yield barrier, a hybrid breeding technology based on cytoplasmic nuclear male-sterility (Saxena *et al.* 2005) and partial natural out-crossing systems was developed (Saxena 2009) at ICRISAT. In comparison to other grain legumes, the growth rate of pigeonpea seedling is slow (Brakke and Gardner 1987) and this condition normally persists for about 30-40 days from sowing and, thereby, makes pigeonpea less competitive to weeds and cereal intercrops. The cultivation of high yielding pigeonpea hybrids could contribute in overcoming the productivity constraints to some extent due to their better germination, establishment of uniform plant stand, faster seedling growth and a high yield potential. Therefore, the present study was undertaken to compare germination and related traits in pigeonpea hybrid and inbred cultivars.

Eleven pigeonpea hybrids and 4 inbred cultivars were identified for this study. The experiment was conducted in 3 replications in a randomized complete block design (RCBD) with a sample size of 100 seeds. The germination test was conducted as per International Seed Testing Association (ISTA) rules using 'Between Paper Towel' (BPT) method (ISTA 2007). The seeds were pre-treated with tetramethylthiuramdisulphide @ 2.5 g/kg and placed in between layers of wet germination papers. The rolled paper towels were placed in a tray with 1-2 cm of distilled water for maintaining sufficient moisture. These trays were kept inside the Percival Scientific Seed Germinator (Model I-35-LLVL) for 10 days.

Data on test weight (g) was recorded as per ISTA (2007). The data on germination (%), root length (cm) and shoot length (cm) were recorded on 10th day after incubation. Subsequently, the seedlings were dried inside craft paper bags at 60±2°C temperature for 48 h and the average dry weight (mg) of seedlings per sample was calculated. Seedling vigour indices were estimated using the following formula (Abdul-Baki and Anderson 1973):

I. Seedling vigour index = Germination % × (Total seedling length)

   Where, Total seedling length = Root length + Shoot length

II. Seedling vigour index = Germination % × Seedling dry weight

   Statistical analyses of the data were performed using SAS version 9.2, Anon (2008).

The analysis of variance revealed highly significant differences among the entries for all the characters studied. The partitioning of treatment mean squares revealed significant differences among hybrids for germination per cent, seedling dry weight, shoot length, root length, shoot: root ratio, and test weight (Table 1). Among inbred cultivars, significant differences were observed for germination per cent, seedling dry weight, shoot length, and test weight. On average, the hybrids exhibited significantly higher germination (99.5±0.26%) over inbred cultivars (96.8±0.26%). Mercer *et al.* (2006) also reported that hybrids exhibited increased seed germination and decreased dormancy over their parents in

Table 1. Statistical significance of treatments on various physiological parameters

Source	df	Germination %	Root length (cm)	Shoot length (cm)	Shoot: root ratio	Seedling vigour index (I)	Seedling dry weight (mg)	Test weight (g)
Treatments	14	0.069**	153.22**	123.77**	2.60**	80054**	1.38**	5.68**
Hybrids	10	0.006	85.05**	143.90**	1.91*	53912	0.74**	3.04**
Inbred cultivars	3	0.074*	6.30	71.10**	1.67	31074	0.18**	2.21**
Hybrid *vs.* Inbred cultivars	1	0.684**	1277.24**	70.86**	11.71**	488419**	11.40**	42.47**
Error	30	0.02	13.77	10.64	0.93	25477	0.03	0.17

*, **: Significant at P = 0.01 and 0.05, respectively

Table 2. Variation for different traits observed among hybrids and inbred cultivars ten days after germination

Genotype	Germination (%)	Root length (cm)	Shoot length (cm)	Shoot: root length	Seedling vigour index	Seedling dry weight (g)	Test weight (g)
Hybrids							
ICPH 4438	99.3	12.38	8.62	0.73	2072	5.6	11.0
ICPH 4430	99.0	12.04	8.47	0.81	2006	5.2	12.5
ICPH 2441	100.0	12.34	6.59	0.58	1895	4.1	12.5
ICPH 2363	100.0	11.61	7.06	0.65	1866	4.5	11.5
ICPH 3310	99.7	12.31	6.36	0.54	1855	4.5	11.5
ICPH 2671	100.0	11.64	5.46	0.49	1840	5.2	10.0
ICPH 4022	99.7	11.07	7.44	0.71	1838	4.0	10.0
ICPH 4013	98.7	11.85	6.23	0.61	1758	4.8	11.5
ICPH 2740	99.3	10.39	6.45	0.67	1728	4.1	13.0
ICPH 3762	99.3	11.41	6.14	0.89	1663	4.8	10.5
ICPH 2364	100.0	10.16	6.12	0.65	1629	4.6	11.5
Mean	99.5	11.56	6.81	0.67	1832	4.7	11.4
Inbred cultivars							
ICPL 88039	98.3	9.63	7.95	0.91	1700	3.9	9.5
Asha	97.7	9.87	7.48	0.95	1655	3.5	10.0
UPAS 120	94.8	10.09	7.24	0.75	1558	3.3	8.0
Maruti	96.2	9.65	6.24	0.73	1472	3.4	9.0
Mean	96.8	9.81	7.23	0.84	1596	3.5	9.13
CV (%)	1.6	33.4	47.2	135.3	9.0	3.8	3.8
SEm (+)	0.13	0.44	0.38	0.11	130.47	0.13	0.33
LSD (5%)	0.26	0.86	0.75	0.22	266.16	0.28	0.68

sunflower.

Mean root length in the hybrids (11.56±0.86 cm) was significantly greater than that of inbred cultivars (9.81±0.86 cm) indicating expression of hybrid vigour for this trait (Table 2). In contrast, the shoots were longer in the inbred cultivars than that in hybrids. This resulted in low shoot: root ratio in the hybrids. According to Saxena *et al.* (1992), one month old seedlings of pigeonpea hybrids produced 44% more shoot mass and 43% more root mass as compared to the inbred cultivars. This data set indicated that the food reserves in the hybrid seed contributed predominantly towards root development.

The root and shoot or total seedling length is known to influence the vigour of seedling which can be used for comparing the genotypes by a parameter called 'seedling vigour index' that takes into account the germination per cent of the individual genotype, giving an overall understanding of their ability to express potential growth at the seedling stage itself. The present study also indicated that the hybrids were significantly vigorous (with the index, 1832±266.2) than the inbred cultivars (1596±266.2). Among the hybrids, 'ICPH 4438' had the highest seedling vigour index (2072) and 'ICPH 2364' had the lowest one (1629). Seedling vigour index was also found to be highly correlated with germination per cent, root length, seedling dry weight and test weight suggesting the important role of these traits in the manifestation of vigour in hybrid seedlings (Table 3).

In pigeonpea, variation for seed yield is primarily attributed to the differences in crop growth rates. Chauhan *et al.* (1995) reported that the yield in pigeonpea hybrid was greater than inbred cultivars; and was primarily associated with higher crop growth rates and the early vigour. They also reported that the differences in plant vigour between hybrids and inbred cultivars began to appear during early seedling stage which became more pronounced with time enabling them suitable for competitive situations. In the present set of materials, test weight was highest in hybrids (11.4±0.33 g) as compared to inbred cultivars (9.1±0.33 g). During the first 10

Table 3. Correlation coefficients observed among different seedling traits

Characters	Seedling dry weight (mg)	Shoot length (cm)	Root length (cm)	Shoot: root ratio	Test weight (g)	Seedling vigour index (I)
Germination (%)	0.667**	-0.153	0.598*	-0.409	0.708**	0.639**
Seedling dry weight		0.091	0.671**	-0.429	0.893**	0.738**
Shoot length			0.045	0.552*	0.063	0.445
Root length				0.505	0.718**	0.858**
Shoot: root ratio					-0.279	0.229
Test weight						0.766**

*, **: Significant at P = 0.01 and 0.05, respectively

days of germination, relatively more quantity of reserved carbohydrates was mobilized for the growth of root in the hybrids. On the contrary, in the inbred cultivars, more carbohydrates were translocated to the development of shoot. Narayanan *et al.* (1981) reported that the seed reserves rather than size of the shoot and root length were important factors in determining seedling size. It was also evident from the present study that the seed size was positively related to germination % (r = 0.708**) and seedling vigour (r = 0.766**). The data also suggested that large seeded hybrids with their relatively vigorous roots are likely to encounter early season drought better than the small seeded hybrids or inbred cultivars. Olisa *et al.* (2010) also suggested that the germination in pigeonpea could be enhanced through the choice of seed size as the cultivars with higher seed weight were found to have higher germination.

The mean dry weight of the hybrid seedlings (4.7±0.28 mg) was significantly more in comparison to inbred cultivars (3.5±0.28 mg) indicating the fact that larger seeds had produced greater seedling biomass and thus, higher dry matter. Narayanan and Sheldrake (1974) demonstrated that the seedling dry weight in pigeonpea inbred cultivars was directly proportional to the test weight confirming again that seedling growth was a consequence of reserve assimilates in seeds. Seedling dry weight was found to be positively associated with seed size, root length and seedling vigour index. The seedling dry matter also indicated that vigour of the pigeonpea seedling in terms of biomass was highly correlated with their longer root and shoot (Kumar *et al.* 2011).

Identification of genotypes with high germination and fast initial seedling growth is likely to result in rapid canopy development for greater light interception, greater suppression of weeds and better seedling establishment. Pigeonpea hybrids are more beneficial than inbred cultivars with respect to enhanced seedling vigour, greater drought tolerance, greater disease resistance and increased grain yield (Saxena *et al.* 1992). Physiological studies have also confirmed that pigeonpea hybrids were superior to inbred cultivars with respect to seedling vigour, growth rate, biomass production, drought resistance and seed yield (Saxena *et al.* 1996). The present study also showed that large seeded hybrids had better germination and more vigorous root system than those in inbred cultivars. Significant and positive correlation between seed size and yield was also reported by Patel and Acharya (2011). Thus, pigeonpea hybrids by virtue of their greater root mass and depth have better abilityto mine receding soil water and tolerate drought during its early phases of growth. The superiority of hybrids in terms of vigour can be identified at early growth stage which may be related to vigour at later developmental stages associated with seed yield. Correlation studies also indicated the association of germination and related traits with vigour of the hybrid seedlings. The present study also indicated the benefits of breeding large seeded hybrids which would give better germination and longer root with better drought tolerance at early growth stages.

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