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CHARACTER ASSOCIATION AMONG SOME WING BEAN (*Psophocarpus Tetragonolobus)* ACCESSIONS FOR SEED QUALITY AND YIELD RELATED ATTRIBUTES

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ABSTRACT

Wing bean, also known as God-sent vegetable, could become an important leafy vegetable, with the pods and seeds rich in protein serving as a multipurpose crop. Despite its many uses, inadequate information on the yield and seed characters limits its improvement. Twenty-five accessions of wing-bean seeds were evaluated for variability, seed quality attributes and yield related parameters. The experiment was laid out in a randomized complete block design in 3 replicates, with seeds sown at a spacing of 50 x 50cm within and between rows. Data taken on seed attributes and yield parameters were subjected to Analysis of variance; means separated using Duncan Multiple Range Test. Correlation matrix was used to determine the level of association among the parameters. Significant differences were observed among the accessions for most of the traits. Root length was positively correlated with shoot length, seedling vigour index, number of pods per plant and seed weight per plot (r = 0.435**, 0.596**, 0.261* and 0.291*, respectively) but negatively correlated with pod/seed ratio (r = -0.311*). Seed yield was positively correlated with shoot length, root length, vigour index, number of pods/plant and number of seeds/plant. Seed vigour and yield- related parameters could be used to improve the yield of the wing bean.

Keywords*: Psophocarpus tetragonolobus;* agro-morphological traits; correlation; seedling traits; variability

INTRODUCTION

Wing bean [*Psophocarpus tetragonolobus* (L.) D.C.], a semi-domesticated tuberous legume belongs to the family *Fabaceae*. It is a tropical multipurpose legume, whose traditional cultivation is mainly distributed in the equatorial Asia; it is basically adapted to warm climate with short day-length (Yulianah, 2020). Wing bean is also known as God-sent vegetable; Goa bean; four angled bean; princess pea and popularly referred to as "*one Species Supermarket"* due to nutrients packed in the leaves, flowers, pods, green or dried seeds and tuberous roots whether cooked or

uncooked (Scriwichai, *et al.*, 2021). Due to its high seed protein, oil content, as well as capacity to fix carbon and nitrogen in the soil, researchers have become more interested in the wing bean as a potential green legume crop that can help overcome food scarcity and resilient production (Tanzi *et al.*, 2019). There is paucity of information on the seed quality indices and seed yield parameters of tropically grown wing bean in Nigeria. Despite having the potentials of becoming a major multi-use food crop in Africa, wing bean has remained an underutilized crop with limited information on its seed vigour, viability and how these traits are associated with yield related parameters (Gadi *et al.*, 2025). There are no breeding programs for wing bean cultivars, because available ones are mostly landraces or selections from landraces.

The objective of this study was to determine the level of association of viability, vigour as well as yield parameters among twenty-five accessions of wing bean

MATERIALS AND METHODS

The field experiment was carried out at the Teaching and Research Farms Directorate of the Federal University of Agriculture, Abeokuta, Ogun State, Nigeria (7°15`N; 3° 25`E) for yield potential, while seed quality assessment was done in the Plant Breeding and Seed Technology Department Laboratory.

Seeds of twenty-five-wing bean accessions were sourced from the Genetic Resources Centre of the International Institute of Tropical Agriculture (IITA), Ibadan, Oyo State. They were; TPT 2, TPT 3, TPT4, TPT 6, TPT 10, TPT 11, TPT 12, TPT 14, TPT 15, TPT 16, TPT 17, TPT 18, TPT 19, TPT 21, TPT 30, TPT 31, TPT 32, TPT 42, TPT 43, TPT 48, TPT 53, TPT 125, TPT 126, TPT 153, and TPT 154.

The land used was ploughed and harrowed to ensure ease of seedling emergence and good plant establishment. Due to the hard seed coat of wing bean, the seeds were scarified using knife to ensure prompt emergence from the soil. The experiment was laid out in a Randomized Complete Block Design (RCBD) in three replications. Total trial size was100 m^2. Plot size was 2.0 x 0.5 m. Planting was at a spacing of 50 x 50 cm with 2-3 seeds planted per hole, thinned to 1 plant/ stand after 2 weeks. Staking was done at 4 weeks after planting (Figure 1). Weeding of the wing bean plot was done fortnightly, while *Cyperforce,* with Cypermetrine as the active ingredient was used to control insect pests. Harvesting was done when the wing bean pods changed from green to ash-brown colour.

Data Collection

Data taken included: Days to seedling emergence, Days to first flowering (days), Days to 50% flowering (days) by counting from date of sowing to day of emergence, Number of pods per plant by visual physical counting of the pods. Plant height (m) was taken from five randomly selected plants per accessions. Pod yield per plant (g), Empty pod weight (g), Pod/Seed ratio, 100 seed weight and Seed yield (t/ha) were taken using digital scale, Number of seeds per pod, Seedling vigour index, Seed viability (% germination), root length and shoot length (cm).

Germination (%): The germination test of each accession was carried out in rolled paper towels in three replicates and kept in an incubator according to AOSA (1970). The germination counts on normal seedlings were taken eight days after planting.

i. Root length (cm): Five seedlings were randomly selected from each germinated sample and root length measured from the collar region to the tip of the primary root. This was carried out with the aid of a ruler. The average root length of five seedlings was computed and expressed in centimeters (Aslanpour, *et al*., 2019), Sabarzo-Bernal *et al*., 2021.

ii. Shoot length (cm): The same five seedlings used for root length were used for shoot length measurement. The length between the collar region and the tip of the primary shoot were considered as shoot length. The average shoot length of five seedlings was computed and expressed in centimeters (Aslanpour, *et al*., 2019).

Seedling Vigour Index: Seedling vigour index was computed by adopting the formula suggested by Bayer, 2025: Vigour index= [Germination (%) × {Shoot length (cm) + Root length (cm)}]

Data collected were subjected to Analysis of Variance; significantly different means were separated using Duncan Multiples Range Test (DMRT) at 5% level of probability. The relationship between various parameters was carried out using correlation coefficient matrix.

RESULTS

Analysis of variance indicated that all the agronomic characters evaluated were highly significant, while block effect was significant for number of pods per plant and shoot length (Table 1). Similarly were the seed characters (Table 2).

Seedling emergence ranged from 7.67 - 11.33 days (TPT 14 - TPT 18), while TPT 18 took the longest days to seedling emerge (11.33) – Table 3. TPT 48 had the highest percent germination (94.67%) after 8 days while TPT 42 had the least percent germination (65.00%). Root length ranged from 7.54 cm to 10.81 cm with an overall mean of 9.02 cm. Shoot length ranged from 12.65- 6.98 cm (TPT 11 and TPT 126). Days to first flowering showed significant differences among accessions. TPT 15 recorded the shortest number of days to first flowering (70.00 days), which was comparable with TPT 19, 21, 2, 6 and 4 (70.67, 71.00, 72.00, 74.33 and 78.00 days, respectively), while TPT 18 seeds that emerged last also recorded the longest days to first flowering (132.00 days) – Table 3.

There were significant differences among accessions with respect to days to vigour index (Table 4). TPT 12 had the highest mean seedling vigour index value (2029.5) while TPT 126 had the least mean seedling vigour index (1051.5). Accession TPT 15 had the highest pod yield (3.02 t/ha, while least pod yield was observed from TPT 16 (1.31 t/ha). The highest number of pods was from TPT 3 (11.53) while TPT 153 had the least number of pods (5.53). The highest number of seeds per pod was recorded from TPT 3 (13.13) which was comparable with TPT 2 (13.07) and TPT 15 (13.00). The least number of seeds per pod was from TPT 32 (7.40). Pod/seed ratio showed significant differences between accessions. The highest pod/seed ratio was from TPT 53 (0.43) while the lowest pod/seed ratio were from TPT 12 and TPT 18 (0.23). Considerable variations were observed among the accessions for 100-seed weight with TPT 14 and TPT 46 having the highest and least 100-seed weight (37.37 and 26.98 g, respectively). This implies that accession TPT 14 had bigger seeds compared to other accessions stud-

ied. Highest seed yield of 1.89 t/ha was observed for TPT 2, the least seed weight of 1.11 t/ha was recorded from TPT 30 (Table 4).

Percentage germination had a significant positive correlation with vigour index, plant height, and 100-seed weight (r = 0.516**, r = 0.275* and 0.228* respectively) but was negatively correlated with days to seedling emergence (r = -0.296**) – Table 5. Root length was positively correlated with shoot length, seedling vigour index, number of pods per plant and seed weight per plot (r = 0.435**, 0.596**, 0.261* and 0.291*, respectively), however it was negatively correlated with pod/seed ratio (r = -0.311*). Plant height showed positive association with pod yield, number of pods per plant and 100-seed weight (r = 0.329**, 0.268* and 0.409** respectively), but negatively correlated with days to first flowering (r = -0.243*). Days to 50% flowering was negatively correlated to pod weight per plot, number of pods per plant, number of seeds per pod and seed weight (r = -0.308**, -0.264*, -0.241* and -0.252*, respectively). Number of pods per plant showed a positive correlation with number of seeds per pod and seed weight (r = 0.344** and 0.361** respectively). Number of seeds per pod was positively correlated with seed weight (r = 0.508**), pod: seed ratio was negatively correlated with the seed weight (r = -0.393**). Seed yield was positively correlated with shoot length, root length, vigour index, number of pods/plant and number of seeds/plant (Table 5).

DISCUSSION

Analysis of variance revealed significant differences among the 25 accessions of wing bean for all the parameters. Ample variability was observed for vegetative characters as obvious from the wide range obtained for root length, shoot length, plant height in the accessions studied. Pan *et al.,* (2005) have similarly reported considerable variability among wing bean.

Yield is the most important character of any crop, genetic component and environmental factors such as humidity, soil nutrient content, rainfall and the interaction of these components (biotic and abiotic factors) play an important role in variation within a population Sabarzo-Bernal *et al*., 2021). Similar differential performances for yield and yield attributes in different accessions of wing bean had been reported by Destia *et al*., 2022. Seed quality and yield traits are complex parameters controlled by polygenes thereby making selection for a single trait difficult. Yield traits are associated with a number of characters, and the relationship between these characters may be of great importance for yield improvement selection programmes (Bhadmus *et al*., 2023). The level of positive association among yield traits provides reliable and useful information in breeding. Singh *et al*., 2021 also reported positive and significant correlation of total pod yield with total number of pods, pod weight and pod length in mung bean (legume). Negative correlation between 100-seed weight and early maturing suggests that accessions tend to partition more assimilates into seed filling, thereby resulting in heavier seeds. In conclusion, seed attributes such as seedling vigour, number of seeds/pod may be used to improve the seed yield related attributes in wing bean. Focus on these attributes improves the potentials of wing bean thereby making it a major multi-use and substitute legume crop. Average performance among the accessions for parameters studied showed TPT 12, TPT 2, TPT 21 and TPT 4 as promising accessions based on their seed-

ling vigour and yields parameters, which would further enhance improvement in wing bean breeding program.

Figure 1: Field view of the experiment

Table 1: Mean square values for some agronomic characters evaluated among 25 Wing Bean Accessions

Source of variation	Df	Seedling emergence (days)	Plant stand	Days to first flowering	Days to 50% flowering	Number of pods (per plant)	Plant height (m)	Pod weight (g)	Number of seeds per pod
Replication	2	0.57	3.72	13.96	9.37	7.53**	0.03	38.92	1.07
Accession	24	2.83**	41.97**	1131.61**	1011.78**	6.47**	1.07**	5898.61**	5.17**
Error	48	0.20	8.94	20.45	26.14	1.20	0.10	29.34	1.73

Table 2: Mean square values for seed characters evaluated among 25 Wing Bean Accessions

Source of variation	Df	Empty pod weight (g)	Pod: seed ratio	Seed weight (g)	100-seed weight (g)	Percentage Germination (%)	Root length (cm)	Shoot length (cm)	Seedling Vigour index
Block	2	12.46	0.00	64.91	0.88	5.69	1.65	14.71**	71442.80
Accession	24	208.65**	0.01**	1693.58**	19.23*	226.52**	3.02**	5.83**	203648.13**
Error	48	7.84	0.00	112.98	10.11	49.15	1.22	1.53	31178.56

* Significance is 5% ($p<0.05$) at probability level, ** Significant at 1% ($p<0.05$) at probability level, Df- Degree of freedom

Table 3: Mean performance of 25 wing bean accessions for agro-morphological parameters.

Accessions	Seedling emergence (days)	Plant stand	Days to first flowering	Days to 50% flowering	Plant height (m)	Percentage Germination (%)	Root length (cm)	Shoot length (cm)
TPT 2	10.33_{bc}	17.00_{b-g}	72.00_{g}	105.00_{kl}	4.00_{bcd}	86.67_{a-d}	10.08_{a-e}	11.40_{a-d}
TPT 3	9.00_{ef}	17.67_{a-g}	99.67_{ef}	107.00_{kl}	3.23_{gh}	79.00_{c-f}	9.98_{a-f}	12.65_{a}
TPT 4	10.33_{bc}	20.00_{a-f}	78.00_{g}	92.00_{mn}	3.46_{d-h}	68.67_{f-i}	9.52_{a-g}	10.98_{a-f}
TPT 6	8.00_{g}	13.33_{ghi}	74.33_{g}	107.67_{kl}	4.48_{bc}	85.33_{a-e}	8.65_{a-g}	8.67_{gf}
TPT 10	9.33_{de}	10.67_{hi}	101.67_{ef}	123.67_{e-i}	2.88_{h}	79.33_{c-g}	8.38_{c-g}	10.56_{a-f}
TPT 11	10.00_{cd}	21.00_{a-e}	102.67_{ef}	120.33_{g-i}	3.71_{d-g}	79.33_{c-g}	10.81_{a}	12.38_{ab}
TPT 12	8.00_{g}	15.67_{d-h}	100.00_{ef}	117.33_{hij}	5.31_{a}	93.33_{ab}	10.40_{abc}	11.40_{a-d}
TPT 14	7.67_{g}	13.33_{ghi}	99.00_{ef}	121.00_{f-i}	4.58_{b}	85.33_{a-e}	8.50_{c-g}	12.10_{abc}
TPT 15	10.33_{bc}	9.00_{i}	70.00_{g}	111.33_{jk}	4.57_{b}	72.67_{e-i}	8.15_{d-g}	10.65_{a-f}
TPT 16	9.67_{cde}	18.00_{a-g}	114.00_{d}	127.00_{d-g}	2.86_{h}	68.67_{f-i}	9.08_{a-g}	11.35_{a-e}
TPT 17	9.67_{cde}	13.33_{ghi}	105.67_{e}	122.00_{f-i}	3.97_{cde}	68.00_{ghi}	10.73_{ab}	11.54_{a-d}
TPT 18	11.33_{a}	15.33_{d-h}	132.00_{a}	161.00_{a}	3.33_{fgh}	90.33_{abc}	9.92_{a-f}	9.54d-f
TPT 19	11.00_{ab}	21.33_{a-d}	70.67_{g}	99.00_{lm}	3.47_{d-h}	80.67_{b-f}	9.54_{a-g}	11.50_{a-d}
TPT 21	8.33_{gf}	23.33_{a}	71.00_{g}	87.00_{n}	3.11_{gh}	85.33_{a-e}	10.33_{a-d}	12.17_{abc}
TPT 30	9.67_{cde}	20.33_{a-f}	103.33_{ef}	119.00_{hij}	3.37_{e-h}	74.00_{e-i}	7.83_{gf}	10.08_{b-f}
TPT 31	9.00e	19.33_{a-f}	97.00_{f}	114.00_{ijk}	3.53_{d-g}	85.33a-e	9.17_{a-g}	10.48_{a-f}
TPT 32	9.67_{cde}	20.33_{a-f}	122.00_{bcd}	136.67_{bc}	3.59_{d-g}	65.33_{hi}	8.85_{a-g}	9.73_{c-f}
TPT 42	9.33_{de}	17.00_{b-g}	129.67_{ab}	163.33_{a}	3.61_{d-g}	65.00_{i}	9.40_{a-g}	9.08_{d-g}
TPT 43	10.00_{cd}	15.00_{fgh}	121.33_{cd}	137.67_{bc}	3.32_{fgh}	72.67_{e-i}	8.58_{b-g}	8.94_{gf}
TPT 48	8.00_{g}	16.00_{c-h}	116.00_{d}	130.33_{c-f}	3.73_{d-g}	94.67_{a}	7.94_{efg}	9.17_{d-g}
TPT 53	10.00_{cd}	22.00_{ab}	118.00_{cd}	132.00_{cde}	3.69_{d-g}	79.00_{c-h}	7.90_{fg}	8.63_{gf}
TPT 125	9.67_{cde}	21.33_{a-d}	125.00_{abc}	141.67_{b}	3.12_{gh}	75.33_{d-i}	8.35_{c-g}	9.81_{c-f}
TPT 126	10.33_{bc}	21.67_{abc}	116.33_{d}	129.00_{c-g}	3.91_{c-f}	72.33_{e-i}	7.58_{g}	6.98_{g}
TPT 153	9.33_{de}	18.33_{a-g}	101.67_{ef}	117.67_{hij}	2.89_{h}	67.33_{ghi}	7.54_{g}	9.98_{b-c}
TPT 154	8.33_{fg}	14.67_{fgh}	106.00_{e}	135.00_{bcd}	4.06_{bcd}	82.00_{a-f}	8.33_{c-g}	9.50_{d-f}

Means with the same letter are not significantly different at 5% probability level according to Duncan Multiple Range Test.

Table 4: Mean performance of 25 wing bean accessions for yield and seed quality attributes

Accessions	Seedling Vigour index	Number of pods (per plant)	Pod weight (g)	Empty pod weight (g)	Number of seeds (per pod)	Pod: seed ratio	100-seed weight (g)	Seed yield (t/ha)
TPT 2	1868.08$_{ab}$	9.00$_{cde}$	284.94$_{b}$	53.03$_{abc}$	13.07$_{a}$	0.28$_{e-j}$	33.37$_{abc}$	1.89$_{a}$
TPT 3	1790.38$_{a-d}$	11.53$_{a}$	192.86$_{gh}$	47.97$_{cd}$	13.13$_{a}$	0.29$_{e-j}$	28.29$_{cd}$	1.68$_{bc}$
TPT 4	1405.42$_{e-h}$	8.60$_{c-f}$	228.06$_{e}$	48.30$_{cd}$	11.73$_{abc}$	0.31$_{d-h}$	31.63$_{a-d}$	1.54$_{cd}$
TPT 6	1479.08$_{d-h}$	7.07$_{efg}$	187.62$_{ghi}$	45.60$_{de}$	10.27$_{abc}$	0.41$_{ab}$	35.91$_{ab}$	1.11$_{h}$
TPT 10	1503.83$_{d-h}$	8.47$_{c-f}$	187.69$_{ghi}$	41.43$_{efg}$	11.73$_{bcd}$	0.25$_{hij}$	28.96$_{cd}$	1.66$_{bc}$
TPT 11	1842.29$_{abc}$	11.27$_{ab}$	185.73$_{hij}$	42.07$_{efg}$	11.53$_{a-d}$	0.32 $_{d-g}$	30.35$_{bcd}$	1.32$_{efg}$
TPT 12	2029.50$_{a}$	10.00$_{abc}$	195.91$_{fgh}$	32.80$_{i}$	11.93$_{abc}$	0.23$_{j}$	32.98a$_{-d}$	1.45$_{de}$
TPT 14	1721.05$_{a-e}$	9.67a$_{-d}$	247.34$_{d}$	39.67$_{fgh}$	10.93$_{a-d}$	0.28$_{e-j}$	37.37$_{a}$	1.41$_{def}$
TPT 15	1365.96f-i	9.60$_{a-d}$	301.66$_{a}$	57.70$_{a}$	13.00$_{a}$	0.31$_{d-h}$	29.52$_{cd}$	1.84$_{ab}$
TPT 16	1405.04$_{e-h}$	7.80$_{def}$	131.05$_{m}$	44.53$_{def}$	12.00$_{abc}$	0.27$_{g-j}$	31.09$_{bcd}$	1.66$_{bc}$
TPT 17	1521.63$_{c-h}$	8.07$_{c-f}$	189.95$_{ghi}$	54.27$_{ab}$	12.80$_{ab}$	0.29$_{e-i}$	29.63$_{bcd}$	1.84$_{ab}$
TPT 18	1758.42$_{a-d}$	6.73$_{fg}$	181.80$_{ijk}$	27.67$_{j}$	9.07$_{de}$	0.23$_{ij}$	29.16$_{cd}$	1.18$_{gh}$
TPT 19	1696.88$_{a-f}$	6.87$_{efg}$	196.89$_{fg}$	37.73$_{gh}$	10.00$_{cd}$	0.29$_{e-j}$	30.86$_{bcd}$	1.30$_{e-g}$
TPT 21	1908.92$_{ab}$	7.53$_{d-g}$	197.11$_{fg}$	35.30$_{hi}$	9.67$_{cde}$	0.27$_{g-j}$	29.25$_{cd}$	1.34$_{efg}$
TPT 30	1321.17$_{ghi}$	8.13$_{c-f}$	248.05$_{d}$	31.93$_{ji}$	12.27$_{abc}$	0.29$_{e-j}$	29.91$_{bcd}$	1.11$_{h}$
TPT 31	1673.58$_{b-f}$	9.33$_{bcd}$	190.07$_{ghi}$	43.63$_{def}$	11.67$_{a-d}$	0.28$_{f-j}$	28.33$_{cd}$	1.58$_{cd}$
TPT 32	1209.50$_{hi}$	8.33$_{c-f}$	264.58$_{c}$	32.57$_{ji}$	7.40$_{e}$	0.27$_{g-j}$	31.57$_{a-d}$	1.22$_{fgh}$
TPT 42	1199.90$_{hi}$	7.73$_{def}$	143.08$_{l}$	54.17$_{ab}$	11.13$_{a-d}$	0.38$_{abc}$	28.25$_{cd}$	1.43$_{de}$
TPT 43	1273.38$_{hi}$	7.07$_{efg}$	180.88$_{ijk}$	45.03$_{de}$	11.20$_{a-d}$	0.36$_{bcd}$	26.98$_{d}$	1.26e$_{-g}$
TPT 48	1621.88$_{b-g}$	6.87$_{efg}$	277.52$_{b}$	46.00$_{de}$	11.13$_{a-d}$	0.37$_{a-d}$	34.50$_{abc}$	1.28$_{e-g}$
TPT 53	1305.50$_{ghi}$	8.33$_{c-f}$	139.90$_{lm}$	52.00$_{bc}$	11.40$_{a-d}$	0.43$_{a}$	33.19$_{a-d}$	1.21$_{fgh}$
TPT 125	1364.27$_{f-i}$	6.60$_{fg}$	177.17$_{jk}$	51.50$_{bc}$	10.13$_{cd}$	0.42$_{a}$	30.02$_{bcd}$	1.22$_{fgh}$
TPT 126	1051.52$_{i}$	7.80$_{def}$	174.31$_{k}$	41.40$_{efg}$	10.80$_{a-d}$	0.34$_{c-f}$	31.43$_{a-d}$	1.22$_{fgh}$
TPT 153	1183.42$_{hi}$	5.53$_{g}$	186.45$_{hij}$	32.37$_{ji}$	11.13$_{a-d}$	0.27$_{g-j}$	28.58$_{cd}$	1.20$_{gh}$
TPT 154	1461.04$_{d-h}$	6.53$_{fg}$	205.33$_{f}$	52.77$_{abc}$	11.00$_{a-d}$	0.34$_{cde}$	30.02$_{bcd}$	1.54$_{cd}$

Means with the same letter are not significantly different at 5% probability level according to Duncan Multiple Range Test.

Table 5: Correlation coefficients matrix for the parameters evaluated among 25 accessions of wing bean

X/X	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16
X1	-	0.17	0.06	0.52**	-0.30**	-0.12	0.28*	-0.18	-0.14	0.16	-0.13	0.12	-0.04	-0.05	0.23*	-0.06
X2		-	0.44**	0.60**	0.09	-0.02	-0.02	-0.16	-0.15	-0.08	-0.05	0.26*	0.07	-0.31**	0.04	0.29*
X3			-	0.65**	-0.11	0.00	0.00	-0.37**	-0.41**	0.12	-0.08	0.23*	0.20	-0.37**	-0.03	0.32**
X4				-	-0.22	-0.08	0.19	-0.35**	-0.33**	0.13	-0.18	0.25*	0.08	-0.37**	0.18	0.24*
X5					-	0.18	-0.34**	0.08	0.14	-0.06	0.00	-0.05	-0.08	-0.06	-0.31**	0.02
X6						-	-0.28*	0.08	-0.09	-0.23*	-0.28*	-0.11	-0.16	0.03	-0.12	-0.35**
X7							-	-0.24*	-0.11	0.33**	0.14	0.27*	0.19	0.05	0.41**	0.11
X8								-	0.90**	-0.41**	-0.11	-0.18	-0.24*	0.17	-0.13	-0.32**
X9									-	-0.31**	0.01	-0.26*	-0.24*	0.22	-0.12	-0.25*
X10										-	0.02	0.15	0.07	-0.19	0.21	0.22
X11											-	0.16	0.37**	0.59**	0.00	0.50**
X12												-	0.34**	-0.17	0.14	0.36**
X13													-	-0.07	0.00	0.51**
X14														-	0.08	-0.39**
X15															-	-0.05
X16																-

* Significance is 5% ($p<0.05$) at probability level ** Significant at 1% ($p<0.05$) at probability level

X1=Percentage germination (%); X2= Root length (cm); X3= Shoot length (cm); X4= vigour index; X5= Seedling emergence (days);
X6= Plant stand per plot X7=Plant height (m); X8= Days to first flowering (days); X9= Days to 50% flowering (days);
X10= Pod weight (g); X11= Empty pod weight (g); X12=Number of pods per plant; X13= Number of seeds per pod;
X14= Pod: seed ratio; X15=100-seed weight (g); X16=Seed weight (g)/ plot

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