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# "Genetic Improvement of Vegetable Type Pigeonpea (*Cajanus cajan* L.)"

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***Abstract:*** *The pigeonpea for vegetable purpose is well balanced nutritionally and an excellent source of protein eaten as a as dried grain. In addition to protein, pigeonpea provides carbohydrates and 5-fold higher levels of Vitamin A and C. Pigeonpea seeds are known to be rich in proteins (generally varying from 18 to 25% and as high as 32%), carbohydrates and minerals. Likewise, the seeds are rich in sulphur-containing amino acids, methionine and cysteine. Its abundance in protein, makes it an ideal supplement to traditional cereal, banana or tuber-based diets of poor farmers that are generally protein deficient. Vegetable pigeonpea is characterized by large pods and seeds because of easy shelling. Some parts of India prefer green pod colour but the study revealed that pod colour does not play important role in determining the organoleptic qualities of vegetable pigeonpea. Thus, vegetable pigeonpea breeding programme will be conducted for prime objectives like, early podding, high multiple harvesting potential, long attractive green pods with non-sticky pod surface and fully grown medium to large sees, easy shelling ability, good taste and high digestible protein content.*

***Keywords:*** *Vegetable Pigeonpea, Genetic Improvement, Quality parameters etc.*

## INTRODUCTION

Among sub-tropical legumes, pigeonpea or red gram (*Cajanus cajan* L. Millspaugh) occupies important place in rain fed agriculture. Maharashtra stands first in area, production as well as productivity of pigeonpea in India. Pulses occupied an area of about 68.31 million hector contributing 57.32 metric tonnes of production to the world food basket. India shared 35.2 per cent of area and 27.65 per cent of global pulses production. India is the largest producer of pulses in the world occupying an area of about 34 million hectors, with annual production of 23.70 million tonnes and yield 697 kg/ha [Project Coordinators' report (2012-13), IIPR, Kanpur]. Maharashtra is one of the leading states in India producing pulses and having area 11.6 million hectors with annual production 10.67 million tonnes, ranking third after Madhya Pradesh and Utter Pradesh.

Pigeonpea [*Cajanus cajan* (L.) Millsp., Family-Fabaceae], is one of the major pulse crops of the tropics and sub-tropics, grown in approximately 50 countries in Asia, Africa and the Americas, mostly as an intercrop with cereals. India is the largest producer with 3.4 million ha, followed by Myanmar (5,80,000 ha), China (60,000 ha) and Nepal (28,000 ha). About 95% production of pigeonpea is from south Asia, 90% of which belongs to India.

Pigeonpea pods are consumed as green vegetable in many countries. Dry seeds of pigeonpea are consumed as split dhal. Pigeonpea is also used as ration for milch cattle. Its straw is also palatable and green leaves may be used as fodder. Sticks of pigeonpea are used for various purposes such as thatch and basket making, etc. Recently its use as a fodder crop has increased. Seed and Fodder contains approx. 20-22% protein. Seeds are rich in Iron, iodine, and essential amino acids like Lysine, Cysteine and Arginine. Pigeonpea being a leguminous plant is capable of fixing atmospheric nitrogen and thereby restore lot of nitrogen in the soil (Gowda, 2011). Protein content of the pigeonpea seeds is about 2-3 times more than the cereals. The proteins of pigeonpea are nutritionally superior and important. It contains B-complex vitamins. It also contains minerals like calcium, iron, phosphorus etc. Seeds of pigeonpea are highly nutritious and used as food and fodder. Nutritious and wholesome, the green

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seeds (and pods) serve as vegetable. Ripe seeds are a source of flour, used split (dhal) in soups or eaten with rice. The vegetable type pigeonpea had higher amount of poly-saccharide and low crude fibre content than dal irrespective of their seed sizes (Mentreddy *et al.* 2002)

The review related to vegetable pigeonpea were collected and presented here which will be helpful for genetic improvement through the variability, association and direct and indirect effect among the qualitative and quantitative characters especially in vegetable purpose genotypes in pigeonpea for quality nutrition.

## REVIEW OF STUDIES CONDUCTED ON VEGETABLE TYPE PIGEONPEA

A comprehensive review of studies conducted an essential part of any scientific investigation, necessary to undertaken the further research on quality nutrition through vegetable type pigeonpea.

Harbans *et al.* (1999) reported that green immature seeds of pigeonpea are used as a vegetable and could be important income for small and part-time farmers. Seeds of pigeonpea are known to be a rich source of proteins, carbohydrates and minerals with protein content generally varying from 18 to 25% and as high as 32%. Pigeonpea seeds are rich in sulfur containing amino acids, methionine, and cysteine.

According to Gowda *et al.* (2011), pigeonpea seeds have appreciable amount of unavailable certain vital nutrients. Some of anti-nutritional factors such as phytolectines are heat sensitive and destroyed during cooking some of the flatulence causing oligo-saccharides such as stay chose, raffinose and verbascose are also present in pigeonpea seeds. Out of the total amino acids, 6.7% is arginine, 1.2% cysteine, 3.4% histidine, 3.8% isoleucine, 7.6% leucine, 7% lysine, 1.5% methionine, 8.7% phenylalanine, 3.4% threonine, 2.2% tyrosine, 5% valine, 9.8% aspartic acid, 19.2% glutamic acid, 6.4% alanine, 3.6% glycine, 4.4% proline, 5% serine with nil values of canavanine, citrulline and homoserine. Methionine, cysteine and tryptophan are the main limiting amino acids present in the green seeds of pigeonpea.

Sometimes very young pods are harvested (before the seeds develop) and cooked like French beans in curries. The other food items that can be prepared from pigeonpea are fresh sprouts, *Tempe*, ketchup, noodles, snacks and various extruded food products. Pigeonpea floor is an excellent component in the snacks industry and been recommended as an ingredient to increase the nutritional value of pasta without affecting its sensory properties as suggested by Mentreddy *et al.* (2002).

Snapp *et al.* (2003) concluded that pigeonpea is an important, multi-use shrub legume of the tropics and subtropics. Pigeonpea is versatile crop, vegetable products includes immature pod and seeds that have just reached physiological maturity, before the green colour is lost. It is well balanced nutritionally and excellent source of protein, whether eaten as green pea or dried grains and in addition to protein, it provides carbohydrate and 5-fold higher level of vitamin A and C than green peas. It has a wide range of products including the dried seed preliminarily used as *Dahl*, a processed, dehulled, split seed, pod and immature seeds used as green vegetables, leaves and stems used for fodder and soil improvement, and the dry stem as fuel. It makes an outstanding contribution to home production system by enhancing both human and soil nutrition.

Thanki and Sawargaonkar (2010) path coefficient analysis (genotypic and phenotypic) revealed that number of pods per plant, test seed weight and harvest index made maximum direct contribution towards seed yield per plant in pigeonpea. Correlations of number of pods per plant and harvest index were also significant and positive which were reflected in path analysis as high direct effects. Days to 50% flowering and pod width showed positive direct effect on green pod yield per plant. In addition to this, number of branches per plant and plant height contributed indirectly *via* number of pods per plant towards seed yield per plant.

Saxena *et al.* (2010a) observed that vegetable pigeonpea is good source of protein, vitamins (A, C and B complex), minerals (Ca, Fe, Zn, Cu), carbohydrates and dietary fibres. In comparison to green peas (*Pisum sativum*) vegetable pigeonpea has five times more beta carotene content, three times more thymine, riboflavin and niacin content, double vitamin C content. Besides it has higher shelling per cent (72%) than that of green pea (53%). These all factors indicate that pigeonpea is nutritionally rich vegetable and it can be used in daily cuisine.

Sexena *et al.* (2010b) revealed that pigeonpea is rich in starch, protein, calcium, manganese, crude fibre, fat, trace elements, and minerals. Besides high nutritional value, it is also used as various medicinal

properties due to presence of a number of polyphenols and flavonoids and also capable to prevent and cure a number of human aliments such as bronchitis, coughs, pneumonia, respiratory infection, dysentery, menstrual disorders, sores, wounds, abdominal tumours, toothache, and diabetes. It has found that vegetable pigeonpea are considered superior to dry spits in crude fibre, fat, protein digestibility as well as trace elements and minerals.

Upadhyaya *et al.* (2010) reported that cluster analysis based on score of first five principal components resulted in tree clusters that differed significantly for days to 50% flowering, days to 75 % maturity, shelling percentage and soluble sugars. Important traits of vegetable pigeonpea such as immature pod length, seed per pod, seed soluble sugars and protein content had shown strong correlation. Caribbean and Eastern Africa were found as the best source region for vegetable pigeonpea. Vegetable pigeonpea can be grown in backyards, field bund band and also as a commercial crop. The fresh seeds can also be foreign and canned for commercialization and export. The Dominican Republic stands first in exporting commercialization of vegetable pigeonpea to United States and other countries.

Gowda *et al.* (2011) reported that vegetable pigeonpea can be good source of valuable proteins, vitamins, carbohydrates, and dietary fiber for humans. The anti-nutritional factors like phytolectines are also present in pigeonpea, but it is heat sensitive and destroyed during cooking. Vegetable pigeonpea compliments the nutritional profile of cereals, and is a good source of protein, vitamins (A, C and B complex) and minerals (Ca, Fe, Zn, Cu). Vegetable pigeonpea scores manifold advantages over green peas (*Pisum sativum*). It has more than five times beta carotene content, three times more Thiamine (Vitamin $B_1$), Riboflavin (Vitamin $B_2$), and Niacin. The ascorbic acid content is more than two times over peas. Similarly, it scores over peas in terms of minerals such as calcium and copper (more than two times higher), and magnesium. Besides all this, the shelling percentage of vegetable pigeonpea is 72 per cent compared to 53 per cent of green peas. In pigeonpea, seed size and pod size are invariably correlated. The large podded types have large immature and dry seeds. These all factors indicate that pigeonpea is nutritionally rich vegetable and it can be used in daily cuisine.

Sharma *et al.* (2011) reported that vegetable pigeonpea is rich source in starch, protein, calcium, manganese, crude fibres, fat, trace elements and minerals. Besides, its high nutritional value, pigeonpea is also used as traditional folk medicine in India, China, Philippines and some other countries. It has been found that vegetable pigeon pea is considered superior to dry splits in crude fibre, fat, protein digestibility as well as trace elements and minerals. Pigeon pea is known to prevent and cure human ailments like bronchitis, coughs, pneumonia and respiratory problem.

Singh (2012) concluded that India is world's biggest home of vegetarian inhabitants and legumes are main source of protein in their diet, pods are consumed fresh, or processed as vegetable either dried seed are use as dahl or variety of preparation. The main stream accepted vegetable pigeon pea varieties should have long pods with large sweet seeds, which can easily be separate from the pod shell. In vegetable type genotype of pigeonpea normal sugar levels are around 5.0%; but researchers at ICRISAT have identified varieties, such as ICP 7035, with a sugar content as high as 8.8% and such germplasm of vegetable type pigeonpea of perennial nature has been identified and explored from Vaishali district of Bihar. Table 1 showed the comparison of green pigeonpea seeds and *dal for* important quality constituents and Table 2 showed the mineral elements (mg/100g) identified in fresh green seeds of a vegetable line 'ICP 7035' and *dal* of a pigeonpea recently released variety.

**Table 1**
**Comparison of green pigeonpea seeds and *dal for* important quality constituents.**

| *Sr. No.* | *Biochemical Constituent* | *% Contents in Green seeds* | *% Contents in "Dal"* |
|---|---|---|---|
| 1 | Starch content (%) | 48.4 | 57.6 |
| 2 | Starch digestibility (%) | 63.5 | 54.8 |
| 3 | Protein (%) | 21.0 | 24.6 |
| 4 | Protein digestibility (%) | 76.8 | 60.3 |
| 5 | Soluble sugars (%) | 5.6 | 5.2 |
| 6 | Crude fibre (%) | 8.9 | 1.2 |
| 7 | Fat (%) | 2.3 | 1.6 |
| 8 | Trypsin inhibitor (units $mg^{-1}$) | 2.8 | 13.5 |
| 9 | Flatulence factors ($g\ 100^{-1}$ souble sugar) | 10.3 | 33.4 |

Vijayalakshmi *et al.* (2013) investigated the seed as well as green pod yield being the most important and pollygenically controlled complex character, is also govern by many physiological changes within the plant and influence by many environmental

**Table 2**
**Mineral elements (mg/100g) identified in fresh green seeds of a vegetable type variety 'ICP 7035' and *dal* of a pigeonpea recently released variety.**

| Sr. No. | Name of Mineral Element | Fresh green Vegetable Seed In ICP 7035 | Dal (Recent released variety) | Superiority of Vegetable Seeds over Dal (%) |
|---|---|---|---|---|
| 1. | Phosphorus | 264.0 | 206.0 | 28.2 |
| 2. | Patassium | 1498.0 | 1279.0 | 17.1 |
| 3. | Calcium | 92.3 | 114.3 | - 19.2 |
| 4. | Zinc | 3.07 | 2.07 | 48.3 |
| 5. | Copper | 1.39 | 1.15 | 20.9 |
| 6. | Iron | 5.16 | 4.50 | 14.7 |
| 7. | Manganese | 1.49 | 1.11 | 30.8 |
| 8. | Magnesium | 108.3 | 108.5 | – |

factors when cultivated; hence it is not an efficient character for selection. Interrelationship among direct and indirect effect of component characters of yield is important in predicting the correlation response to direct selection and in detection of traits with much effects as markers. The present study was under taken to elucidate the association between green pod yield and its attribute in pigeonpea, over drought condition.

Birhan *et al.* (2013) phenotypic path analysis studies in vegetable type pigeonpea showed that, days to maturity had the highest positive direct effect on seed yield followed by seeds per plant whereas; genotypic path analysis revealed that, maximum direct effect on seed yield was exerted by days to flowering and reproductive phase followed by seeds per plant and plant height. Thus, seeds per plant and plant height were the potent contributor to seed yield which could be used as indirect selection criteria. The plant height showed negative direct effect on pod yield per plant. The results from correlation and path coefficient analyses showed that selection for yield improvement through days to flowering, plant height, seeds per plant, pod filling duration and biomass yield per plant.

Lakhote *et al.* (2015) studied on genetic analysis of 24 vegetable type genotypes in Pigeon pea (*Cajanus cajan* (L.) was studied by using variability, correlation and path coefficient analysis to find out the variation, association among characters and to measure the direct and indirect contribution of eleven characters on green pod yield per plant. Genotypic and phenotypic coefficient of variation were of high magnitude for plant height, 100 green pod weight, 100 green seed weight, Shelling percentage (%), TSS (%), days to 50% flowering, pod length, pod width as well as for number of primary branches. The estimate of high heritability (bs) accompanied with high-expected genetic advance for 100 green pod weight and days to 50% flowering indicating the presence of additive gene action in the expression of these characters. This suggesting that such traits can be improved by direct selection. The genotypic correlation studies pod length (0.2266), pod width (0.1127), seed per pod (0.0026), 100 green pod weight (0.0383), 100 green seed weight (0.3583), shelling percentage (0.4283), number of flower cluster (0.2260) indicated that green pod yield per plant exhibited stable positive association with traits expect days to 50% flowering (–0.1917), number of primary branches (–0.0479) and TSS (–0.0342). While the phenotypic correlation revealed that, days to 50% flowering (–0.1731), number of primary branches (–0.0358) and TSS (–0.0387) were negatively correlated and the rest of all characters were positively correlated with green pod yield per plant. The direct effects of path coefficient analysis revealed that the green pod yield per plant had positive and significant with days to 50% flowering (0.0588), pod width (0.9276), pod length (0.4526), seed per pod (0.0062), 100 green pod weight (0.0652), 100 green seed weight (0.2128), shelling percentage (0.3972), number of flower cluster (0.3709) and the rest of the effects of few characters were negative for number of primary branches(–0.0246) and TSS (–0.0068). Moreover, it was noticed that, high indirect contribution was contributed through green pod yield per pod with most of the yield contributing traits. Hence, the traits *viz*., 100 green pod weight, days to 50% flowering, seeds per pod and 100 green seed weight should be given more consideration while deciding about selection criteria for vegetable type genotypes in pigeonpea.

## CONCLUSION

This crop has wide range of uses and its use as fresh or canned green peas is common in parts of India, Africa, Central America and Caribbean's. The immature seeds of pigeonpea can be used as vegetable, which is nutritious than the dry seeds. The green vegetables pigeonpea has good market in west and frozen and canned peas could be exported to the western countries. As the pigeonpea for vegetable purpose is well balanced nutritionally and an excellent source of protein whether eaten as a green pea or as dried grain. In addition to protein, pigeonpea provides carbohydrates and 5-fold higher

levels of Vitamin A and C. Pigeonpea seeds are known to be rich in proteins (generally varying from 18 to 25% and as high as 32%), carbohydrates and minerals. Likewise, the seeds are rich in sulphur-containing amino acids, methionine and cysteine. Its abundance in protein, makes it an ideal supplement to traditional cereal, banana or tuber-based diets of poor farmers that are generally protein deficient. Vegetable pigeonpea is characterized by large pods and seeds because of easy shelling. Some parts of India prefer green pod colour but the study revealed that pod colour does not play important role in determining the organoleptic qualities of vegetable pigeonpea.

Thus, vegetable pigeonpea breeding programme will be conducted for prime objectives like, early podding, high multiple harvesting potential, long attractive green pods with non-sticky pod surface and fully grown medium to large seeds, easy shelling ability, good taste and high digestible protein content.

## REFERENCES


Birhan Techale, Habtamu Zelekeand Amsalu Ayana. (2013), Path coefficient analyses and correlation of seed yield and its contributing traits in pigeonpea [*Cajanus cajan* (L.) Millsp]. *Indian J. Agric. Res*., **47**(5): 441-444.

Gowda C.L.L., R.K. Srivastava, K.B. Saxena and R.V. Kumar. (2011), Vegetable Pigeonpea. [*Cajanus cajan* (L) Millspaugh]. *Future Crops*. **1**(15): 260-276.

Harbans L. B., Muddappa Rangappa and Anwar A. Hamama. (1999), Chickpea, Faba Bean, Lupin, Mung bean, and Pigeonpea: Potential New Crops for the Mid-Atlantic Region of the United States. *Perspectives on new crops and new uses. ASHS Press, Alexandria.* 202-205.

Lakhote S. J., H. E. Patil, R. A. Mali and P. Ingle. (2015), Genetic analysis for yield and yield contributing traits in vegetable type genotypes in Pigeon pea (*Cajanus Cajan* (L.) Millsp.). *Tropical J. Agril. Sciences*., **33**(2): 1-7.

Mentreddy, S.R., A.I. Mohamed., N. Joshee and A.K. Yadav. (2002), Edamame: A Nutritious Vegetable Crop. *Trends in new crops and new uses*, 432-438.

Saxena, K.B., R.V. Kumar and C.L.L. Gowda. (2010a), Vegetable pigeonpea a review. *Journal of Food Legumes*. **23**(2): 91-98.

Saxena, K.B., R.V. Kumar and Rafat Sultana. (2010b), Quality nutrition through pigeonpea-a review. ICRISAT, Pantcheru, India. Book, **2**(11): 1335-1344.

Saxena, K.B., Singh, U. and Faris, D.G. (2002), Does pod colour affect the organoleptic qualities of vegetable pigeonpea. International Pigeonpea Newsletter **2**: 74-75.

Sharma, S., N. Agarwal and P. Verma. (2011), Pigeon pea *(Cajanus cajan L.*): A Hidden Treasure of Regime Nutrition. *Journal of Function and Environmental Botany*, **1**(2): 91-101.

Singh A.K. (2012), Vegetable pigeonpea type germplasm identified and explored from Vaishali district of Bhihar. *Hort-Flora Research Spectrum*, **1**(4): 312-317.

Snapp, S.S., R.B. Jones, E.M. Minja, J.Rusike and S.N.Silim. (2003), Pigeon Pea for Africa: A Versatile Vegetable and More. *Hort. Science*. 38 (6): 1073-1079.

Thanki, H.P. and S.L. Sawargaonkar. (2010), Path coefficient analysis in pigeonpea (*Cajanus cajan* L. Millsp.). *Electronic Journal of Plant Breeding*, **1**(4): 936-939

Upadhyaya, H.D., K. N. Reddy, C.L.L. Gowda and S. Singh. (2010), Identification and evaluation of vegetable type pigeonpea (*Cajanus cajan (L.) Millsp*.) in the world germplasm collection at ICRISAT gene bank. *Plant Genetic Res.* **8**(2): 162-170.

Vijayalakshmi, P., Anuradha Ch, Pavankumar. D, Sreelaxmi. A. and G. Anuradha. (2013), Path coefficient and correlation response for yield attributes in pigeonpea (*Cajanas cajan* L.). *International Journal of Scientific and Research* Publications, **3**(4): 1-6.


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