A high yielding pigeonpea variety CRG 2012-25 as CO 9 released for Southern Zone of India

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Abstract
A long duration high yielding Pigeonpea culture CRG 2012-25 as CO 9 was developed at the Department of Pulses, Centre for Plant Breeding and Genetics, Tamil Nadu Agricultural University, Coimbatore was released by Central Variety Release Committee during 2019. It is a cross derivative of CO 6 x IC 525427 with a duration of 170 -180 days, suitable for kharif sowing. This variety yields on an average yield of 1700 kg/ha which is 17.58, 19.00 and 14.61 per cent yield increase over CO 6 (Local check), WRP 1 (Zonal check) and ICP 8863 (national check), respectively. It recorded maximum yield of 2697 kg/ha in Tandur, Telangana. This variety has bold seeds (100 seed weight of 9.0 - 10.0 g) with a protein content of 23.65 per cent. It is moderately resistant to wilt and SMD diseases and the pests viz., Maruca and pod fly. This variety is suitable for the southern zone of India which includes Tamil Nadu, Karnataka, Telengana, Andhra Pradesh and Odisha.

Key words
Pigeonpea variety, long duration, national release, the southern zone

INTRODUCTION
Pigeonpea [Cajanus cajan (L.) Millspaugh.] is the second most important protein-rich pulse crop in India after chickpea and 5th most important crop in the world (Singh et al., 2015). Pigeonpea supplies a major share of protein requirement of vegetarian population of the country. It contains about 22 per cent of protein, which is almost three times than that of cereals (Bajpai et al., 2003). Its main use as pulse, its tender green seeds are used as vegetable and crushed dry seeds as animal feed, fodder, fuel, wood, etc. It plays an important role in sustaining soil productivity by fixing atmospheric N₂ and its fallen leaves enrich the soil with organic matter thus help in maintaining soil fertility. India is the largest producer of the crop contributing to 85 per cent of the total production in the world. In India, the crop occupies an area of 5.39 m. ha with an annual production of 4.87 m. t. and the productivity of 903 / ha (FAOSTAT, 2019).

The World Health Organisation recommended per capita consumption of protein around 80 g/day whereas the per capita availability of protein in the country is about 28 g /day leads to malnutrition for the growing population Saroj et al.(2013). To meet the protein needs genetically stable high yielding varieties are mandatory. The major constraints for productivity of Pigeonpea are inadequate availability of seeds of improved varieties, biotic and abiotic stress and poor crop management. Keeping this importance, pedigree breeding was employed to develop high yielding and long duration variety in Pigeonpea.

MATERIALS AND METHODS
Hybridization programme was made between CO 6 and IC 525427. The selection of Pigeonpea culture CRG 2012-25 was made during 2007. Preliminary Yield Trail and Comparative Yield Trails were conducted during kharif
A high yielding pigeonpea variety

2013 and kharif 2014. This culture was proposed and tested in Multi Location Trial (MLT) and Initial varietal Trial (IVT) during kharif 2015. It was promoted to Advanced Varietal Trial (AVT) I and II during 2016-17 and 2017-18, respectively. The performance was tested in 26 locations of the southern zone of India. Natural and artificial screening was also carried out for its pests and diseases reaction in different locations viz., Badnapur, Bangalore, Coimbatore, ICRISAT, Varanasi and Warangal.

RESULTS AND DISCUSSION

The overall yield performance of the Pigeonpea culture CRG 2012-25 was presented in Table 1. In AICRP trial, an average yield of CRG 2012-25 (26 locations in 2016-2018) was 1678 kg/ha which is 17.58 per cent superior yield than CO 6(local check), 19 per cent increased yield than the WRP-1(Zonal check) and 14.61 per cent increased yield than the national check ICP 8863.

In IVT, CRG 2012-25 has recorded an average yield of 1426 kg/ha which is 12.41 per cent increased yield than WRP-1 (Zonal check), 11.71 per cent over CO 6 (local check) and 6.45 per cent over ICP 8863 (national check) (Table 2).

| Year of testing | Number of locations | CRG 2012-25 | ICP 8863 (National Check) | WRP-1 (Zonal Check) | CO 6 (Local check) |
|-----------------|---------------------|-------------|---------------------------|---------------------|-------------------|
| 2015            | 8                   | 1426        | 1334                      | 1249                | 1259              |
| 2016            | 9                   | 1945        | 1575                      | 1495                | 1566              |
| 2017            | 9                   | 1636        | 1468                      | 1458                | 1437              |
| Weighted Mean   | 26                  | 1678        | 1464                      | 1410                | 1427              |

| Year of testing | Per cent increase over the check varieties | CRG 2012-25 | ICP 8863 (National Check) | WRP-1 (Zonal Check) | CO 6 (Local check) |
|-----------------|-------------------------------------------|-------------|---------------------------|---------------------|-------------------|
| 2015            |                                           | 6.89        | 14.17                      | 13.26               | 1.14              |
| 2016            |                                           | 23.49       | 30.10                      | 24.20               | 1.14              |
| 2017            |                                           | 11.44       | 11.44                      | 13.84               | 1.14              |

| | overall percent increase | 14.61        | 19.00                      | 17.58               | 1.14              |

Table 2. Grain yield (kg/ha) of pigeon pea variety CRG 2012-25 in IVT trial conducted in the southern zone during 2015

| Entries    | Vamban | Coimbatore | Warangal | Guibarga | Bangalore | Lam | Tirupati | Hiriyr | Mean | Per cent increase |
|------------|--------|------------|----------|----------|-----------|-----|----------|--------|------|------------------|
| ICP 8863   | 949    | 926        | 1510     | 1132     | 1780      | 1758| 1175     | 1444   | 1334 | 6.45             |
| CO 6       | 1164   | 1344       | 1042     | 854      | 1487      | 2064| 542      | 1576   | 1259 | 11.71            |
| WRP-1      | 964    | 779        | 1484     | 1153     | 1322      | 1709| 1185     | 1400   | 1249 | 12.41            |

CRG 2012-25

| Entries    | Vamban | Coimbatore | Warangal | Guibarga | Bangalore | Lam | Tirupati | Hiriyr | Mean | Per cent increase |
|------------|--------|------------|----------|----------|-----------|-----|----------|--------|------|------------------|
| CRG 2012-25| 1169   | 1644       | 1128     | 1113     | 1631      | 1743| 1259     | 1720   | 1426 |                  |

Table 3. Grain yield (kg/ha) of Pigeon pea variety CRG 2012-25 in AVT trial conducted in the southern zone during 2016

| Entries    | Vamban | Coimbatore | Warangal | Guibarga | Tandur | Bangalore | Lam | Tirupati | Hiriyr | Mean | Per cent increase |
|------------|--------|------------|----------|----------|--------|-----------|-----|----------|--------|------|------------------|
| ICP 8863   | 1045   | 1203       | 1833     | 2173     | 1609   | 1635      | 2096| 1339     | 1575   | 19   |                  |
| CO 6       | 1338   | 2156       | 1227     | 614      | 2106   | 1764      | 2211| 1751     | 931    | 1566 | 19.5             |
| WRP-1      | 940    | 1316       | 1618     | 1997     | 1713   | 1004      | 2268| 1723     | 877    | 1495 | 23.13            |

CRG 2012-25

| Entries    | Vamban | Coimbatore | Warangal | Guibarga | Tandur | Bangalore | Lam | Tirupati | Hiriyr | Mean | Per cent increase |
|------------|--------|------------|----------|----------|--------|-----------|-----|----------|--------|------|------------------|
| CRG 2012-25| 1370   | 2480       | 1972     | 1431     | 2697   | 1911      | 2196| 2114     | 1336   | 1945 |                  |
Table 4. Grain yield (kg/ha) of Pigeon pea variety CRG 2012-25 in AVT 2 trial conducted in the southern zone during 2017

| Entries   | Vamban | Coimbatore | Warangal | Gulbarga | Tandur | Bangalore | Lam | Tirupati | Hiryur | Mean | Per cent increase |
|-----------|--------|------------|----------|----------|--------|-----------|-----|----------|--------|------|------------------|
| Check varieties |       |            |          |          |        |           |     |          |        |      |                  |
| ICP 8863  | 962    | 948        | 1933     | 1968     | 1611   | 1209      | 1845| 1079     | 1656   | 1468 | 10.26            |
| CO6       | 1397   | 1088       | 1273     | 576      | 1596   | 1834      | 2062| 1543     | 1565   | 1437 | 12.16            |
| WRP-1     | 1000   | 957        | 1752     | 2441     | 1615   | 1175      | 1175| 969      | 1597   | 1409 | 13.87            |
| Proposed culture |     |            |          |          |        |           |     |          |        |      |                  |
| CRG 2012-25 | 1211  | 1685       | 1965     | 1403     | 1991   | 1475      | 1857| 1510     | 1628   | 1636 |                  |

Table 5. Distinguishing morphological characters of the culture CRG 2012-25 and local check CO 6 (as per PPV & FRA)

| S.No. | Characteristics                                      | CRG 2012-25                  | CO 6                      |
|-------|------------------------------------------------------|-----------------------------|---------------------------|
| 1     | Plant anthocyanin coloration of hypocotyls           | Absent                      | Absent                    |
| 2     | Plant –branching pattern                         | Erect                       | Erect                     |
| 3     | Time of flowering                                 | Medium (120-130 days)       | Medium (120-130 days)     |
| 4     | Plant growth habit                                | Indeterminate               | Indeterminate             |
| 5     | Stem colour                                        | Green with brown stripes    | Green                     |
| 6     | Leaf shape                                         | Oblong                      | Oblong                    |
| 7     | Leaf: Pubescence on lower surface of the leaf    | Absent                      | Absent                    |
| 8     | Flower: Colour of base of petal (Standard)       | Yellow                      | Yellow                    |
| 9     | Flower: Pattern of streaks on petal (standard) | Medium                      | Medium                    |
| 10    | Pod : Colour                                       | Green with brown streaks    | Green with purple streaks |
| 11    | Pod: Pubescence                                   | Present                     | Present                   |
| 12    | Pod: Waxiness                                      | Absent                      | Absent                    |
| 13    | Pod: Surface stickiness                           | Present                     | Present                   |
| 14    | Pod: constriction                                 | Prominent                   | Prominent                 |
| 15    | Pod length                                         | 5.3-6.0 (cm)                | 5.1-5.5 (cm)              |
| 16    | Pod: Number of seeds                               | 5-6                         | 4-5                       |
| 17    | Plant height                                       | Tall (210-240 cm)           | Tall (160-180 cm)         |
| 18    | Seed colour                                        | Brown                       | Brown                     |
| 19    | Seed: colour pattern                              | Uniform                     | Uniform                   |
| 20    | Seed shape                                         | Globular                    | Globular                  |
| 21    | Seed :Size (100 seed weight)                      | Large (9.0-10.0 g)          | Medium (7.6 to 8.8g)      |

Table 6. Reaction (%) to wilt disease in Pigeon pea variety CRG 2012-25 and checks during kharif 2016 under the field condition

| Entries                   | Bangalore | Gulbarga | ICRISAT | Warangal |
|---------------------------|-----------|----------|---------|----------|
| CRG 2012-25               | 12.4      | 12.8     | 9.3     | 8.3      |
| ICP 2376 (Susceptible check) | 86.9      | 92       | 95.9    | 87       |
| ICP 8863 (Resistant check) | 8.4       | 10       | 3.1     | 9.3      |

In AVT 1, CRG 2012-25 recorded an average yield of 1945 kg/ha which is 19, 19.5 and 23.13 per cent, increased yield than ICP 8863, CO 6 and WRP-1, respectively (Table 3).

In AVT 2, CRG 2012-25 recorded an average yield of 1636 kg/ha which is 10.26 per cent increased yield over ICP 8863, 13.87 per cent increased yield than WRP-1 and 12.16 per cent increased yield than CO 6 (Table 4).
Table 7. Reaction (%) to wilt disease in Pigeon pea variety CRG 2012-25 and checks during kharif 2017 under the field condition

| Entries                  | South zone |          |          |          |          |
|--------------------------|------------|----------|----------|----------|----------|
|                          | Bangalore  | Gulbarga | ICRISAT  | Warangal |
| CRG 2012-25              | 26         | 20.83    | 8.6      | 9.5      |
| ICP 2376 (Susceptible check) | 100        | 75.9     | 100      | 90       |

Table 8. Reaction(%) to SMD disease in Pigeon pea variety CRG 2012-25 and checks under the artificial epiphytotic conditions during kharif 2016

| Entries                  | Badnapur  | Bangalore  | Coimbatore | ICRISAT  | Varanasi | Warangal |
|--------------------------|-----------|------------|------------|----------|----------|----------|
| CRG 2012-25              | 9.7       | 19.9       | 15.9       | 15       | 23       | 13.3     |
| Bahar (Resistant check)  | -         | -          | -          | -        | -        | 11.1     |
| ICP 8863 (Susceptible check) | 100       | 100        | 100        | 100      | 100      | 100      |

Table 9. Reaction(%) to SMD disease in Pigeon pea variety CRG 2012-25 and checks under the artificial epiphytotic conditions during kharif 2017

| Entries                  | Coimbatore | ICRISAT  | Warangal |
|--------------------------|------------|----------|----------|
| CRG 2012-25              | 15.4       | 21.4     | 8.3      |
| ICP 8863 (Susceptible check) | 100        | -        | -        |

Table 10. Reaction of CRG 2012-25 to major insect pests of under Natural condition

| Centre   | Insect name | Condition | Year | CRG 2012-25 (Damage %) | UPAS 120 (National Check) (Damage %) | CO 6 (Local check) (Damage %) |
|----------|-------------|-----------|------|------------------------|--------------------------------------|-------------------------------|
| Bengaluru | Helicoverpa | Natural   | 2016 | 16.0                   | -                                    | 13.5                          |
|          |             |           | 2017 | 15.97                  | -                                    | 11.24                         |
|          |             |           | 2016 | -                      | -                                    | -                             |
|          | Maruca      | Natural   | 2016 | -                      | -                                    | -                             |
|          | Pod fly     | Natural   | 2016 | 4.50                   | -                                    | 6.90                          |
|          |             |           | 2017 | 4.24                   | -                                    | 3.66                          |
|          | Helicoverpa | Natural   | 2016 | -                      | -                                    | -                             |
|          |             |           | 2017 | 3.7                    | 4.0                                  | 6.3 (CO 8)                    |
| Coimbatore | Maruca      | Natural   | 2016 | -                      | -                                    | -                             |
|          | Pod fly     | Natural   | 2016 | -                      | -                                    | -                             |
|          |             |           | 2017 | 8.7                    | 6.0                                  | 8.0                           |
| Gulbarga  | Pod borers  | Natural   | 2016 | 22.2                   | 22.9                                 | 20.5                          |
|          | Helicoverpa | Natural   | 2016 | 10.5                   | 7.0                                  | 8.3                           |
|          |             |           | 2017 | 4.7                    | 5.0 (WRP 1)                          | 6.7 (LRG 52)                 |
| Guntur    | Maruca      | Natural   | 2016 | 14.5                   | 13.4                                 | 20.2                          |
|          | Pod fly     | Natural   | 2016 | 7.17                   | 13.3 (WRP 1)                         | 16.2                          |
|          |             |           | 2017 | 5.1                    | 6.2                                  | 12.1                          |

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Table 11. Grain quality characteristics of Pigeon pea variety -CRG 2012-25 along with check CO 6

| Variety       | Characteristics | CO 6   | CRG 2012-25 | CO 6   | CRG 2012-25 |
|---------------|-----------------|--------|-------------|--------|-------------|
|               | Physical        |        |             |        |             |
|               | Length (cm)     | 0.6    | 0.62        | 0.58   | 0.6         |
|               | Breadth(cm)     | 0.49   | 0.55        | 0.47   | 0.54        |
|               | Thickness(cm)   | 0.30   | 0.38        | 0.08   | 0.09        |
|               | 100 dhal weight(g) | 9.78  | 11.76      | 3.95   | 5.02        |
|               | Sprouting volume(100 g) | 176.0 ml | 215.0 ml | -     | -           |
|               | Chemical        |        |             |        |             |
|               | Moisture g/100g | 10.70  | 10.90       | 11.04  | 11.65       |
|               | Ash g/100g      | 3.54   | 3.62        | 2.71   | 2.75        |
|               | Protein g/100g  | 18.92  | 19.56       | 21.27  | 23.65       |
|               | Starch g/100g   | 58.0   | 55.0        | 55.7   | 56.7        |
|               | Fat g/100g      | 1.62   | 1.86        | 1.31   | 1.2         |
|               | Crude fiber g/100g | 6.7   | 6.78        | 2.05   | 2.09        |
|               | Iron mg/100g    | 2.33   | 2.62        | 2.02   | 2.12        |
|               | Cooking         |        |             |        |             |
|               | time (min)(open)| 39     | 32          | 28     | 20          |
|               | Increase in     | 1:1.95 | 1:2.25      | 1:1.90 | 1:2.03      |
|               | volume ratio    |        |             |        |             |
|               | Organoleptic    |        |             |        |             |
|               | testing         |        |             |        |             |
|               | Color and       | 8      | 9           | 9      | 9           |
|               | acceptance      |        |             |        |             |
|               | Flavour         | 8      | 9           | 8      | 9           |
|               | Texture         | 8      | 9           | 8      | 9           |
|               | Taste           | 8      | 9           | 8      | 9           |
|               | Overall         | 8      | 9           | 8      | 9           |

As per the guidelines from PPV and FRA, New Delhi distinguishing morphological characters of the culture CRG 2012-25 was formulated and compared with the check variety CO 6. (Table 5). CRG 2012-25 has green with brown streaks pods, brown seeds and 100 seed weight of 9-10 grams.

The reaction of pigeon pea culture CRG 2012-25 to major diseases viz., wilt and SMD along with the national checks were presented in Table 6 to Table 9. CRG 2012-25 recorded a moderate resistant reaction to wilt and SMD. The reaction of pigeon pea variety CRG 2012-25 to major pests viz., Maruca and Pod fly along with the national checks were presented in Table 10. CRG 2012-25 recorded a moderate resistant reaction to Maruca and Pod fly.

The results of the organoleptic evaluation of the dhal also revealed the superiority of this culture with the overall acceptability score of 9 (Table 11).
Fig. 1. DNA finger printing profile for CRG 2012-25 (as CO 9) redgram

L-100bp Marker, 1-BRG 2, 2-BRG 3, 3-Malaituvarai Local, 4-CRG 13-01, 5-CRG 2012-25
DNA finger printing of Pigeon pea culture CRG 2012-25 was done with varieties viz., BRG2, BRG3, Malaituvarai Local and CRG 13-01 using Pigeon pea specific SSR markers viz., CcM 1026, CcM 0008, CcM 0257, CcM 0948, PGM 5 and PKS 26. Out of this, four markers viz., CcM 1026, CcM 0008, CcM 0257 and CcM 0948 were found to be polymorphic and clearly differentiated CRG 2012-25 with other varieties (Fig.1).

Hence, based on the superiority of the pigeon pea culture CRG 2012-25, it has been recommended for release by the Central Variety Identification Committee and notified (SO 220(E)/5.9.2019) for cultivation in southern zone of India viz., Tamil Nadu, Karnataka, Telangana, Andhra Pradesh and Odisha.

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