Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2017; 6(5): 2651-2657
Received: 14-07-2017
Accepted: 15-08-2017

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Ways to bridge yield gaps and production problems in pigeonpea cropping systems

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Abstract
Redgram is the second most important pulse crop in India. India stands first in area (3.63 m ha) and production (2.76 m t). It accounts 20 per cent of total pulse production of the country. As 'dal', pigeonpea is an important constituent of the Indian meal. It contains 21 per cent protein and is rich source of energy in vegetarian's diet. Over 90 % of the global pigeonpea is grown in India. The major pigeonpea growing states are Maharashtra, Karnataka, Uttar Pradesh, Andhra Pradesh, Gujarat and Madhya Pradesh. In various agro-climatic regions, different maturity group (long, medium and short duration) of pigeonpea are grown. Long duration (250-280 days) varieties are grown in north eastern plains zone where as medium maturity variety (160-180 days) in central India and south India short duration (130-150 days) are grown in north western region under different cropping system. In the last two decades, the area under long duration pigeonpea has considerably reduced where as there is significant increase in area under medium and short duration varieties. The major constraints to low productivity of pigeonpea are in adequate availability of seeds of improved varieties, biotic and abiotic stresses and poor crop management. seed treatment with Rhizobium + PSB is beneficial to get higher yield, ridge sowing/planting method gives higher grain yield and helps in overcoming the Phytophtora blight during water logging and avoids wilt disease. Sowing before 15th July helps in getting higher yields by avoiding heavy infestation of insect pests, pre-emergence application of pendimethalin @ 1.00 kg a.i. ha^{-1} + One HW at 50 DAS controls weeds and given higher pigeonpea grain yield. The purpose of this is to examine the literature reports that what are all the ways to fill the yield gap between traditional and modern practices which are very much play an important role in minimizing the constraints in cropping systems and achieved sustainable yield level in Pigeonpea crop.

Keywords: Yield gap, biotic stress, modern practices, water logging and pre-emergence

1. Introduction

Pulses are an important commodity group of crops that provide high quality protein complementing cereal proteins for pre-dominantly substantial vegetarian population of the country. Although, being the largest pulse crop cultivating country in the World, pulses share to total food grain is production is only 6-7% in the country. The cultivation of pulses buildsup a mechanism to fix atmospheric nitrogen in their root nodules and thus meet their nitrogen requirements to a great extent. In India, pulses can be produced with a minimum use of resources and hence, it becomes less costly even than animal protein. In comparison to other vegetables, pulses are rich in protein which are less expensive and can be cultivated as an inter-crop and also as mixed crop. Pulses are mostly cultivated under rainfed conditions and do not require intensive irrigation facility and this is the reason why pulses are grown in areas left after satisfying the demand for cereals/cash crops. Even in such conditions, pulses give better returns. Apart from this, pulses possess several other qualities such as they are rich in protein, improve soil fertility and physical structure, fit in mixed/inter-cropping system, crop rotations and dry farming and provide green pods for vegetable and nutritious fodder for cattle as well.

Although this crop group is more important from the nutritional point of view, there has not any significant increase in area and production during 1950-51 to 2009-10; however, significant growth in area and production has been recorded during the last five years (i.e. 2010-2011 to 2014-15). With the increase in infrastructural and irrigation facilities/resources, the pulses get the marginalized treatment pushing them to another poor and marginal land piece. The productivity of pulses has increased about 68% at 764 kg/ha during 2013-14 from the level of 441 kg/ha during 1950-51. It is imperative to mention that the New Agriculture Technology (NAT) introduced during mid-sixties has increased the production of food-grains from 50.82 million tonnes during 1950-51 to 265.64 million tonnes during 2013-14 with the increase in area from 97.32 million hectares to 125 million hectares. The productivity of food grains has also sharply increased to 2120 kg/ha during 2013-14 from the level of only 522 kg/ha during 1950-51.

The potential of pulses to help address future global food security, nutrition and environmental sustainability needs has been acknowledged through the UN declaration of the 2016 International Year of Pulses. Pulses are a Smart Food as these are critical for food basket (dal-roti, dal-chawal), important source of plant protein and help address obesity, diabetes etc. In addition pulses are highly water efficient, can grow in drought prone areas and help improve soil fertility by fixing soil nitrogen.

It is grown throughout the country except the regions having very low temperature. Pigeonpea fixes up to 200 kg N ha^{-1} (Anon., 2010). It is estimated that pigeonpea has a beneficial effect on subsequent crops as it supplies about 40 kg N ha^{-1}. The leaf drop helps in improving soil structure, the stalks of pigeonpea serve as an efficient fuel and are also used for thatch making and its deep, strong root system breaks the hard pans and improves the soil structure. Hence, pigeonpea is often called as "a biological plough" and kalpavriksha of dry lands as all parts are useful. In Karnataka, it is grown in an area of 0.74 m ha with a production of 0.48 m t and average yield of 712.19 kg/ha (Anon., 2015).

Long duration pigeonpea is cultivated mostly on marginal lands in mono/mixed cropping system without any fertilizers under rainfed conditions. Its productivity is very low (700 kg ha^{-1}) as compared to its potential yield (2800 kg ha^{-1}). This wide yield gap can be minimized through the use of adequate and balanced fertilization (Singh and Yadav, 2008).

Table 1: Area, production and productivity of pigeonpea

Region	Area (m ha)	Production (m t)	Productivity (kg ha^{-1})
India	4.65	3.03	760.33
Karnataka	0.74	0.48	712.19

Source: FAO statistics (2015-16)

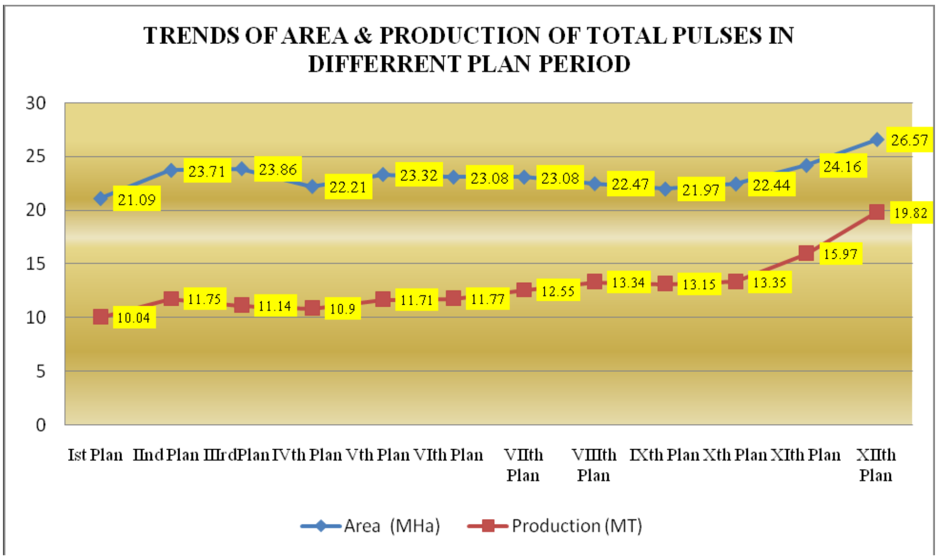

Fig 1

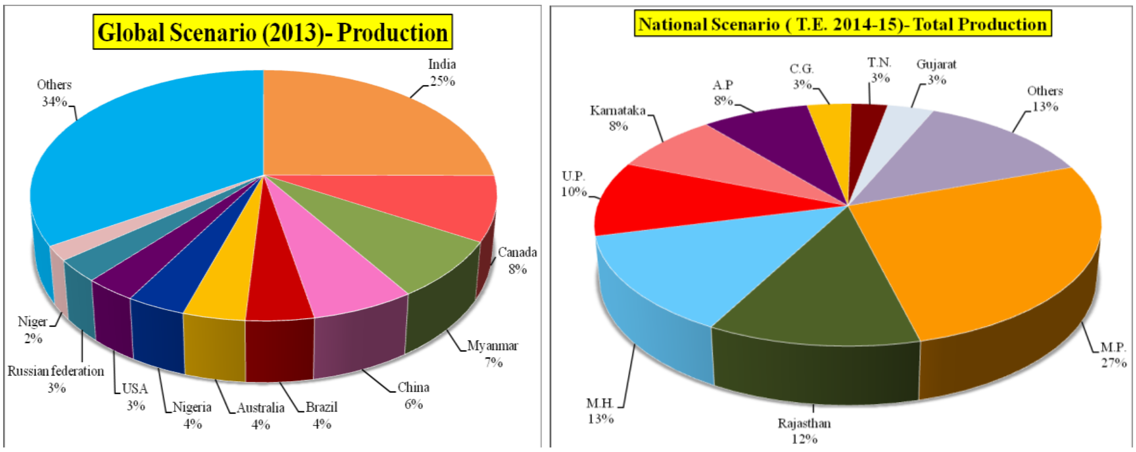

Fig 2

Table 2: Area, Production and Productivity of Pigeonpea in Major States

S. No.	Particulars	Area (lakh ha)	% Share	Production (lakh t)	% Share	Productivity (kg ha^{-1})
1	Andhra Pradesh	4.63	12.75	3.02	10.94	652.27
2	Gujarat	2.65	7.30	2.94	10.65	1,109.43
3	Karnataka	6.81	18.76	4.85	17.57	712.19
4	Madhya Pradesh	3.50	9.64	2.17	7.86	620.00
5	Maharashtra	11.75	32.37	10.83	39.24	921.70
6	Uttar Pradesh	3.68	10.14	3.27	11.85	888.59
	India	36.30		27.60		760.33

Source: Directorate of economics and statistics (2013-14)

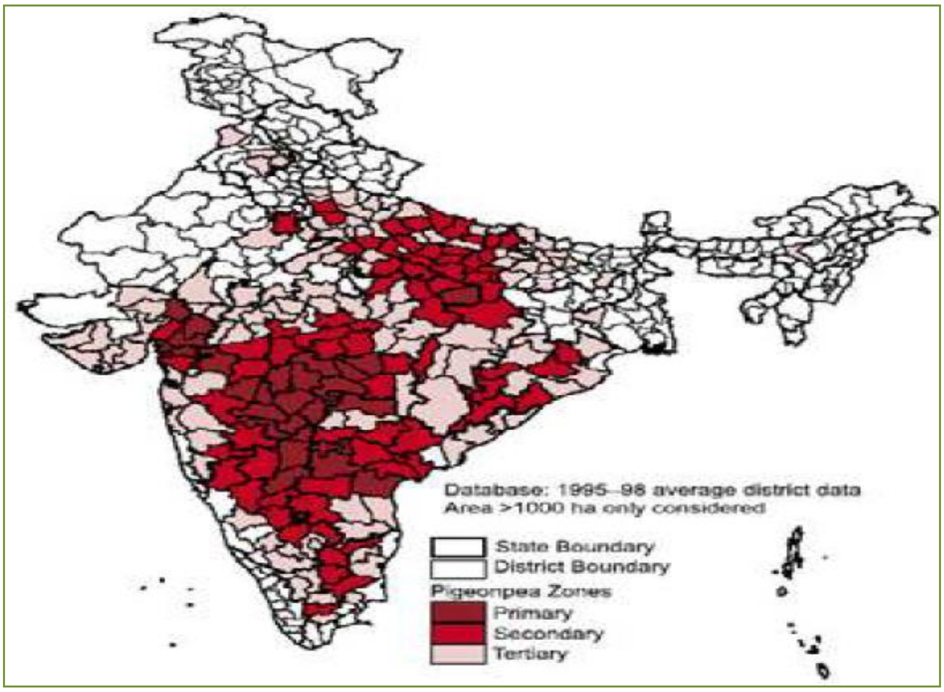

Fig 3: Primary, secondary and tertiary production zones of pigeonpea in India

Table 3: Area, Production and Average yield of pigeonpea in Karnataka for 2013-2014

S. No	District	Area (Lakh ha.)	Production (Lakh tonnes)	Yield (kg ha^{-1})
1	Bagalkote	0.0105	0.0027	274
2	Bangalore - Rural	0.013	0.0141	1115
3	Belgaum	0.042	0.0161	402
4	Bellary	0.096	0.0436	477
5	Bidar	0.626	0.5012	842
6	Bijapur	0.486	0.1947	421
7	Chamarajanagar	0.023	0.0118	531
8	Chickaballapur	0.082	0.0409	523
9	Chitradurga	0.095	0.0403	446
10	Davanagere	0.044	0.0360	856
11	Dharwad	0.035	0.0267	794
12	Gadag	0.013	0.0040	309
13	Gulbarga	3.797	1.9446	539
14	Hassan	0.017	0.0061	366
15	Haveri	0.023	0.0130	591
16	Kolar	0.032	0.018	592
17	Koppal	0.094	0.0400	445
18	Mandya	0.011	0.0061	556
19	Mysore	0.031	0.0159	535
20	Raichur	0.135	0.0353	275
21	Ramanagaram	0.037	0.0238	671
22	Shimoga	0.005	0.0028	556
23	Tumkur	0.194	0.1040	562
	Total	596622	315020	556

Source: Directorate of Economics and Statistics, Bangalore

Table 4: Pigeonpea based intercropping systems followed in India

With cereals	With pulses	Other crops
Sorghum + Pigeonpea	Pigeonpea + green gram	Groundnut + Pigeonpea
Pearl millet + Pigeonpea	Pigeonpea +cowpea	Sunflower + Pigeonpea
Pigeonpea + maize	Pigeonpea + black gram	Pigeonpea + sesame
Setaria + Pigeonpea	Pigeonpea + soybean	
Rabi sorghum + Pigeonpea	Pigeonpea + dolichos bean	
Finger millet + Pigeonpea		

Constraints in production of pigeonpea
Agro-ecological constraints

- Cultivation on marginal and sub-marginal lands
- Rainfed crop (uncertain and in sufficient rainfall- terminal stress)

II. Biological constraints

- Crop domestication (survival under adverse situation)
- Inherent low productivity (genetic yield potential)
- Heavy losses due to store grain pests (traditional storage

structures)
- Susceptible to pests and diseases

III. Management Constraints
- Lack of timely availability of quality seeds of improved varieties (SRR is only 2-5 %)
- Inadequate supply of quality insecticides, herbicides and fungicides
- Lack of post harvesting facilities
- Poor transfer of technology (FLD's and BD need of hour)
- Non availability of proper farm implements

IV. Technical Constraints
- **Cultivars:** poor genetic potential, susceptibility to disease and pests.
- **Technology:** lack of Integrated crop production and management, wide spread S and Zn deficiency

V. Socio-economic constraints
- Poor market information system
- Lack of quality storage facility
- Absence of proper and accurate climate forecast
- Non-availability of labour at the time of harvesting was the major constraint
- High rate of inputs in the production
- High transportation charges

Particulars showing the adoption constraints of pigeonpea Constraints
Technical Constraints
Non-availability of quality seed material
Non-availability of sulphur based phosphatic fertilizer for balanced nutrition
Incidence of pests and diseases
Non-availability of appropriate plant protection chemicals
Infestation of weeds
Lack of proper knowledge about seed treatment
Socio-economic Constraints
Non-availability of inputs in time
Non-adoption of proper crop rotation
Lack of knowledge about scientific Cultivation practices
Difficulty in assessing credit facilities
Increasing cost of inputs

Agro-ecological Constraints
Occurrence of flood/water logging
Poor soil quality
Aberrant weather

Wankhade *et al.*, 2009 [26] (Table 4) shows, the constraints in purchasing the seeds and the major constraint was non-availability of seed of good quality. It was also expressed by farmers that some inert materials were mixed in seeds and this was followed by high seed price. Further, expensive seeds were not affordable for them. Lack of information about recommended variety, non availability of required variety, need to travel long distance and non-availability of credit facilities were also the important constraints found at the time of purchasing the seeds.

Concept of Yield GAP
According to Gomez (1977) yield gap is the difference between the potential farm yield and actual farm yield and the factors responsible for it are called as yield constraints.

There are two types of yield gaps.
- Yield gap I and yield gap II.
- Yield gap I = Potential theoretical yield - Potential farm yield
- Yield gap II = Potential farm yield - farmers' yield

The yield gap is assessed in pigeonpea as 809 kg ha^{-1} and 511 kg ha^{-1} in Karnataka and India, respectively (Chaturvedi and Massod Ali, 2002) [13].
Bhatia *et al*., (2007) noticed that across different states, the Yield gap I (YG I) ranged from 0 to 430 and 190 to 510 kg ha^{-1} when estimated by using simulated and experiment station yield data, respectively. The magnitude of Yield gap II (YG II) was highest in Andhra Pradesh (1190 kg ha^{-1}) followed by Maharashtra (830 kg ha^{-1}), Karnataka (770 kg ha^{-1}), Madhya Pradesh (650 kg ha^{-1}), Gujarat (400 kg ha^{-1}) and Tamil Nadu (70 kg ha^{-1}).
YG I is difficult to abridge as it is because of environmental differences between on-farm and research station situations or those assumed during simulations such as theoretically optimum conditions created during simulations and very small plot sizes with optimum homogeneity and the technical expertise at research stations. The variations observed among different regions for YG I thus, could be because of the above factors. Though YG I cannot be abridged completely, it gives an indication on the upper limits of productivity that can be achieved in a given environment. If the YG I is very narrow, it indicates the need to generate further technologies such as improved varieties that can perform better in a given environment. On the other hand, YG II is manageable as it is mainly due to the differences in the management practices and input use. In case of pigeonpea on an average this gap is 700–800 kg ha-1 for the major pigeonpea growing regions such as primary and secondary production zones, AEZ 6 and states of Maharashtra, Karnataka, Andhra Pradesh and Madhya Pradesh. The narrowing of such a large gap can help in doubling the production of pigeonpea in the country.

Strategies to bridge yield gaps
Short term strategies
1. More area should be brought under high yielding varieties in fertile soils having protective irrigation and supplementation of organic matter, rhizobium, PSB & PGPR (Plant growth promoting rhizobacteria).
2. Should be grown as pure crop with intensive cultivation and inputs like any other cereals.
3. Production and timely supply of quality seeds, bio-fertilizers, chemical fertilizers and micronutrients at farmer's level.
4. Protective irrigation at critical stages like flowering and pod formation enhances yield
5. Effective plant protection management with the available IPM technology combining with growing available resistant varieties and advocating use of effective insecticides for controlling pod borers and storage pests (bruchids).
6. Popularization of improved varieties, INM and IPM technology by way of FLD's and large scale demonstrations.
7. Aggressive and committed extension efforts by various organizations like university, KVK and NGO's, through extensive demonstrations.
8. Value addition of pigeonpea for higher returns.
9. Development of good post harvest – milling/ processing/ storage facilities.

10. Establishing mini dhal meals at village/ gram panchayath levels.

Long term strategies
1. Breeding high yielding varieties resistant to wilt, SMD, pod borers and drought.
2. Integration of classical breeding methods with the DNA marker technology for enhancing selection process to detect the desired genotype in record time.
3. Application of biotechnological tools to produce transgenics for biotic and abiotic stresses.
4. Development of suitable early maturing varieties for late planting situations to escape terminal moisture stress and utilization in multiple cropping systems.
5. Development of CMS based hybrids and effective seed production technology.

Selection of varieties and hybrids

Table 5: Pigeonpea varieties recommended (ICAR 2007) for Different zones

States	Recommended cultivars
Andhra Pradesh	LRG 38, LRG 41, LRG 30,GTH 1, ICPL 88039, PRG 158, ASHA, DURGA, PRG 100, ICPH 2671
Karnataka	SEL31, TS 3, TTB 7, BRG 1, BRG 2, Asha (ICPL 87119), Maruthi (ICPH 2671).
Madhya Pradesh	ICPL 88039, GTH 1, UPAS 120, GT 101, MAL 13, ICPL 151, AKPH 4101 (hyb), ICPH 2671.
Maharashtra	ICPL 88039, GTH 1, UPAS 120, GT 101, MAL 13, Manak, MA 3, ICPL 151, Jawahar, Sharad, BSMR 175, ICPH 8, ICPH 2671.
Uttar Pradesh	ICPL 88039, GTH 1, UPAS 120, Pusa 992, MA 6, Azad, Amar, Pusa 9, Pusa 855, Birsa Arhar 1.
Tamil Nadu	Co RG 9701, CoPH 2, Co 6, UPAS 120, Asha, Vamban 1.
Gujarat	GTH 1, ICPL 88039, GT 101, MAL 13, ICPL 151, GT 101, MA 3, AKPH 4101 (hyb), Jawahar, Asha, Gujarat tur 100.

Temburne *et al.* (2009) reported that the variety DEPS 9 was recorded significantly higher grain yield (2959.38 kg ha^{-1}), plant height (211 cm), number of pods per plant (264.13) and hundred seed weight (11.83 g). This was mainly due to the genptype very much suitable for irrigated conditions than all other treatments.

Genotype TTB-7 performed better in sole cropping as well as in intercropping with either mungbean or soybean. The yield of pigeonpea was more in pigeonpea + mungbean intercropping (1:1) wherein mungbean residue after pod picking was used as mulch in pigeonpea compared to that in sole pigeonpea. Higher pigeonpea grain equivalent yield (PGYE) was obtained in pigeonpea + mungbean intercropping of which TTB 7 + mungbean (1:1) recorded higher PGYE of 3795kg ha^{-1} with LER of 1.81(Anon., 2005).

Singh and Singh (2012) reported that dual inoculation of PSB + PGPR produced significantly higher grain yield (2.24 t/ha) and other yield attributes as compared to sole seed treatment with PSB, PGPR and control.

Singh, (2006) noticed that maximum grain yield was obtained when the crop was sown on 10th July and it was on par with planting on 25th July during both the years. Grain yield was significantly reduced when the planting was delayed to august 9th. Similarly, maximum pods per plant, stalk yield and harvest index were found in early planting as compared to delayed planting during both the years. Among the four varieties, Pusa 9 produced significantly higher grain yield and other parameters followed by NDA 1 during both the years.

Anon., (2012) [10], observed transplanting of 4-5 weeks old seedlings of pigeonpea recorded significantly higher grain yield (2177 kg ha^{-1}) in sole crop and also in ragi + pigeonpea intercropping (8:2) recorded higher PGEY (1626 kg/ha) as compared to direct sowing of pigeonpea (1229 kg ha^{-1}) (Anon, 2012) [10].

Mishra *et al.* (2009) [2, 17] reported that ridge planting was found to significantly superior to flat bed planting with respect to plant height, pods per plant and grain yield during both of the years. The maximum plant height was recorded along with higher plant population and it increased simultaneously with the increase in number of plants per hectare, but it was vice-versa in number of branches per plant and pods per plant. However, grain yield was found to significantly higher in higher plant densities during both 2003 and 2004 experimentation years (1575 and 2374 kg ha^{-1}, respectively). Whereas, the higher number of pods per plant were observed at lower plant population compensating for the loss in yield due to fewer plants per unit area.

Set furrow cultivation is one of the *in situ* moisture conservation practices. This system is widely practiced by the farmers of Sourashtra region of Gujarat, where cultivation of crops in the wider rows is done and these rows are set permanently over long period in the dryland areas for higher crop productivity. It conserves rain water effectively and offers an excellent drought proofing mechanism. Infiltration rate is increased considerably by reducing the runoff and soil loss. The soil will be able to provide the moisture throughout the growth stages of the crops and also improve the soil physico-chemical and biological properties.

In the pooled analysis, Arjun Sharma (2009) [11] reported that, the number of pods per plant of pigeonpea (165.25) intercropped with sesame (1:2) under set-furrow cultivation with vermicompost application @ 2.5 t ha^{-1} was significantly higher by 18 per cent when compared to flat bed system (139.98 $plant^{-1}$). The hundred seed weight of pigeonpea (9.41g) intercropped with sesame (1:2) under setfurrow cultivation with vermicompost applied @ 2.5 t ha^{-1} was significantly higher by 3 per cent when compared to flat bed system (9.20 g). The seed yield of pigeonpea (15.58 q ha^{-1}) intercropped with sesame (1:2) under set-furrow cultivation with vermicompost application @ 2.5 t ha^{-1} was significantly higher by 20 per cent when compared to flat bed system (12.96 q ha^{-1}).

The pooled data revealed that the intercropping of pigeonpea with greengram (1:2) under set-furrow cultivation with vermicompost application @ 2.5 t ha^{-1} recorded significantly higher gross returns (Rs.50,489 ha^{-1}), which was significantly superior over other treatments. The sole crop of greengram recorded lowest gross returns (Rs.15, 564 ha^{-1}) compared to other treatments (Arjun Sharma, 2009) [11].

The grain yield of pigeonpea did not differ significantly due to intercropping of finger millet or mungbean in pigeonpea genotypes. However, pigeonpea variety ICPL 87119 performed better in both sole cropping and intercropping with finger millet or mungbean than TTB-7. ICPL 87119 responded to foliar application of 2% urea, whereas in TTB-7, no response to 2% urea foliar spray was noticed. Higher pigeonpea grain yield equivalent of 1973 kg/ha was obtained with ICPL 87119 + finger millet (2:1) intercropping than that with pigeonpea + mungbean (1:1) intercropping. LER was more than 1 in pigeonpea + mungbean/ finger millet intercropping indicating the compatibility of growing finger millet or mungbean as an intercrop in pigeonpea (Anon., 2004) [5].

Ali, 1994 [3], reported that Pigeonpea/pearl millet intecroppping is practiced in the semi-arid and arid regions of northwestern and peninsular India and West Africa, particularly on light, textured soils. Pearl millet with its quick tillering and fast growth often suppresses pigeonpea, however, the total productivity from this system is higher than that from sole crops. Results of field experiments conducted under AICRPDA on Alfisols in peninsular India showed that pigeonpea/pearl millet (1:2 rows) system is highly efficient with an LER ranging from 1.38 to 1.81.

Subba Rami Reddy, *et al.,* 2011, found that application of 50% RDF through inorganic fertilizer + Rhizobium @200g/kg seed at the time of sowing recorded higher grain yield 1358.4 kg/ha followed by RDF+FYM + Rhizobium (1325.233 kg/ha) and 50% RDF + Rhizobium + PSB (1304.5). However the differences found non significant in these three treatments. Application of FYM, Rhizobium and PSB combination treatments recorded higher yields than only RDF treatment. The increase in yield with the addition of Rhizobium is possibly due to higher nitrogen availability as it improves growth, quality and yield of field crops.

Application of 20 kg P_2O_5/ha through DAP along with *Bacillus polymyxa* recorded yield (1567 kg/ha) almost similar to 40 kg P_2O_5/ha through DAP. It was also observed that application of 40 kg P_2O_5/ha through rock phosphate along with either *B. Polymyxa or Aspergillus awamori* was as effective as application of 40 kg P_2O_5/ha through DAP. Thus, PSB was more useful for rock phosphate (Anon., 2001).

Verma *et al.* (2004) [25] reported that application of Zn (foliar spray 0.5% $ZnSO_4$) increased the plant height (115.5 cm), pods per plant (185) and seed yield of pigeonpea (1942 kg ha^{-1}) as compared to other treatment. However it was on par with seed soaking (0.5% $ZnSO_4$) + foliar spray and seed soaking (0.2% borax) + foliar spray. This may be due to accumulative effect of growth characters and also yield attributes as it contains Zn which is involved in IAA synthesis.

Manoj Kumar Yadav *et al*., 2012 [18], reported that among weed management practices, two sequential hand weeding recorded maximum dry matter accumulation and yields of pigeonpea and rice and minimum weed density and dry weight which was followed by pendimethalin + one hand weeding at 45 DAS. This was likely owing to minimum weed competition for water, nutrient and space.

Srinivas Rao *et al.* (2007) [12, 22] found that the major insects in redgram are pod borers viz., *Helicoverpa armigera*, *Exelastis atomosa*, *Melanagromyza obtusa* and also the webbing insect, *Maruca vitrata* and reported that intercrops significantly alter the pod damage and grain damage by pod borers and were least pod and grain damage was observed by pigeonpea intercropping with sorghum followed by pigeonpea + blackgram and pigeonpea + groundnut intercropping systems. This is mainly because of sorghum is tall plant act as a perching site for predatory bird they fed on larvae and also overlapping of pod formation and flowering of pigeonpea with ear-head formation of sorghum might have reduced the feeding damages to main crop pigeopea by the pests.

Gopali *et al.,* (2010) [15] reported less number of webs in pigeonpea + sorghum (0.62) and pigeonpea + bajra (0.75) compared to all other inter cropping systems.

Agrawal and Tripathi (2003) [1] reported that estimated that is 5-10% yield loss due to *Phytophthora* blight and 10-15% from *Fuzarium* wilt. the minimum early stage mortality (10.0%) due to *Phytophthora* blight incidence (4.3%) and wilt incidence (1.2%) were recorded under pigeonpea + sorghum (2:2) intercropping system with highest pigeonpea equivalent yield (1640 kg ha^{-1}), which was at par with pigeonpea + sorghum (1:1 and 2:1) intercropping systems (Table 40). The reduced wilt incidence in pigeopea intercropped with sorghum is attributed to root secretion of Hydrocyanic acid (HCN) and the root exudates of sorghum delayed the germination of *Fusarium* sp.

Mandhare and Suryavamshi (2008) [16] reported that spray of botanical preparations of *Ocium sanctum (L.) Eucalyptus sp. Nerium indicum* and *Azardirachta indica* recorded signififcantly higher percent (100 %) of *Fusarium udum* incidence in pigeonpea at Rahuri (Maharashtra) in black cotton soils.

Pigeonpea IPM module

- Seed treatment with *Trichoderma* spp. to reduce wilt incidence
- Intercropping with sorghum efficiently reduces wilt and pod borer
- Fixing of Pheromone traps for monitoring
- Physical shaking of plants to dislodge grownup pod borer larvae.
- Spray of HaNPV for pod borer management
- Crude neem extract 5% (NSKE) against pod borer and pod fly
- Chemical pesticides (Emamectin benzoate) under high pest load

Table 6: Technology contribution to yield

Technology	Contribution (%)
Improved varieties	24.5
Rhizobium inoculation	13.5
Sulpher application	17.4
IPM	28.1
Weed management	30.0

New Delhi, Anon., 2009

Conclusion

Asha and Maruthi (Northern Karnataka) BRG-1 and BRG-2 (Southern Karnataka) are the varieties found to be best for Karnataka, seed treatment with Rhizobium + PSB is beneficial to get higher yield, ridge sowing/planting method gives higher grain yield and helps in overcoming the Phytophtora blight during water logging and avoids wilt disease. Sowing before 15th July helps in getting higher yields by avoiding heavy infestation of insect pests, pre-emergence application of pendimethalin @ 1.00 kg a.i. ha^{-1} + One HW at 50 DAS controls weeds and given higher pigeonpea grain yield, spraying botonicals like Eucalyptus and Tulasi controls *fusarium* wilt and Intercropping with Sorghum helps in attracting natural enemies.

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