Journal of AgriSearch, 7(3):115-120
An Open Access International Peer Reviewed Quarterly
ISSN : 2348-8808 (Print), 2348-8867 (Online)
https://doi.org/10.21921/jas.v7i03.18683
Review

Post-Rainy Season Pigeonpea Holds Promise for the Diversification of Cropping Systems

ARBIND K CHOUDHARY[1*], RAKESH KUMAR[1], KUL BHUSHAN SAXENA[2#] AND ANIL KUMAR SINGH[1]

ARTICLE INFO
Received on : 14-06-2020
Accepted on : 23-08-2020
Published online : 01-09-2020

ABSTRACT

The temporal and spatial intensity of rainfall in north-east plains (Central and Eastern Uttar Pradesh, Bihar, Jharkhand, West Bengal, Assom and North-Eastern states) often leads to temporary waterlogging, causing partial to complete mortality of pigeonpea seedlings during rainy season. Post-rainy season (September) plantings may be adopted as an alternate approach to address the issue of waterlogging and crop diversification. Research conducted at the ICAR-RCER, Patna has shown that sowing of 'Pusa 9' during second week of September after harvest of quality protein green cob maize provided up to 3.0 t/ha grain yield under zero tillage with optimum crop management practices (one hand weeding, one-two insecticide spray of *imidacloroprid* @1mL/L water at 10 days' interval commencing from second fortnight of February). Similarly, 'IPA 203' sown on September 20, 2018 yielded more than 3.0 t/ha under conventional tillage practices (N: P: K: 20:50:0; two hand weeding; one irrigation during second fortnight of December and two spray of the same insecticide at the same interval). These findings indicate that the system is agronomically feasible, economically highly remunerative and ecologically sustainable to bring about diversification in upland ecology of north-east plains of India.

KEYWORDS
Adaptation, Crop mangement, Diversification, Plant phenology, Post-rainy pigeonpea

INTRODUCTION

In the past seven decades, increasing agricultural production and ensuring food security has been the main agenda of agricultural development. To the great satisfaction, Indian farmers with the help of agricultural scientists and policy makers could achieve it by bringing in 'Green Revolution' and 'Rainbow Revolution'. This not only brought smiles at the face of millions of Indians, but also established India as the self-sufficient country in agriculture, leading to face-lifting of Indian agriculture on the world map. The increase in production and productivity became possible through intervention of better crop production technologies and varieties, among few others (Singh *et al.* 2017). This has resulted in an about six-fold increase in food grain production, making India not only food self sufficient at aggregate level, but also a net food exporting country.

The post green revolution era resulted in the adoption of rice-wheat cropping system in the Indo-Gangetic plains of India comprising parts of both north-west (Punjab, Haryana and western Uttar Pradesh) and north-east (central and eastern Uttar Pradesh, Bihar, Jharkhand, Assom and west Bengal) plains. This enhanced food and nutritional security in these regions; however, it displaced grain legumes from the system (Choudhary *et al.*, 2018; Singh *et al.*, 2015). For example, in Bihar and West Bengal (of Eastern Gangetic Plains), grain legumes (pulses) hardly account for 8-10% of the total cropped area. The total acreage under pulses during 2016 came down to 498 and 345 thousand ha as compared to 788 and 704 thousand ha during 2001 in Bihar and WB, respectively (AICRPP, 2019). In addition, many nutritionally rich crops including millets became out of cultivation. Over the last 50 years, this has narrowed down not only crop total diversity, but has also led to a loss of dietary diversity ultimately bringing down *nutrient to calorie* ratio across the regions (Dwivedi *et al.*, 2017). Low income population of both the states, depending entirely on rice, wheat and maize for their calorific needs has witnessed a great resurgence of malnutrition with micronutrient deficiency (particularly iron, zinc and Vitamin A deficiencies) being the major cause of malnutrition. This has posed an additional threat to nutritional security in these regions (Choudhary, 2019). Moreover, a declining trend in the system productivity *per se* of rice-wheat, rice-rice or rice-maize cropping systems has been observed. Diversification of these cropping systems with grain legumes is required to enhance dietary diversity, and sustain soil health, system productivity and agro-ecosystem (Dwivedi *et al.*, 2017).

Pigeonpea [*Cajanus cajan* (L.) Millsp.] is unique among pulses as it has the ability to sustain the changes due to various biotic and abiotic stresses (Khan *et al.*, 2019). These characteristics have made it possible to cultivate the crop on marginal land mostly under rainfed situation where the risk of crop failure is very high (Saxena *et al.*, 2018b). This pulse has been very popular among rainfed farming communities due to its abilities to fix atmospheric nitrogen, release soil-bound phosphorus, and recovery from drought and other stresses (Arumugam *et al.*, 2018; Saxena, 2008). This crop is known to have higher vegetative growth (biomass) and lower harvest index, typical to a wild species. This adaptation trait helps impart genotypic plasticity to the crop (Choudhary, 2011; Kumar *et al.*, 2019). These characteristics enable pigeonpea to produce sufficient biomass even under

[1]ICAR Research Complex for Eastern Region (ICAR RCER), Patna, Bihar, India
[2]International Crops Research Institute for Semi Arid Tropics (ICRISAT), Patancheru, Telangana India
[#]Present address: 19/5 Al Mudaredh, Al Ain, Abu Dhabi, United Arab Emirates
*Corresponding author email : akiipr23@yahoo.com

delayed plantings. Therefore, it can be an ideal candidate pulse crop of post-rainy season to bring about diversification of the existing cropping systems especially in north-east (NE) plains.

An analysis of declining trend of pigeonpea area in North-East Plain

NE plains comprising central and eastern Uttar Pradesh (UP), Bihar, West Bengal (WB) and Assom have been the traditional home to long-duration pigeonpea which takes around 8-9 months from sowing to harvesting (Choudhary and Nadarajan, 2011). This crop was conventionally grown mostly under rainfed condition in mixed/intercropping system often with tall cereals such as maize, sorghum and minor millets (small and little millets). After the harvest of short duration cereals and millets, pigeonpea crop used to remain in the field for another 4-5 months (Saxena *et al.*, 2018b). This cropping system which was mostly followed in upland ecology maintained and sustained not only dietary diversity, but also maintained physical condition and fertility status of soil. After the advent of green revolution, sole cropping with semi-dwarf varieties of rice and wheat supplanted the traditional system of mixed cropping (Dwivedi *et al.*, 2017). Such subsistence mixed cropping also received tough competition from some more remunerative intercropping systems such as maize-potato intercropping, now widely practiced in north Bihar and eastern UP. Moreover, unstable yield of pigeonpea caused by erratic rainfall pattern also compelled farmers to look for some other alternative cropping systems. All these led to continued decline of acreage under pigeonpea crop in NE plains. It is clear from Table 1 that pigeonpea area in UP and WB during 2017-18 declined by more than 51% and 82%, respectively over the year 1970-71. In Bihar, the pigeonpea area came down to 66.2 thousand ha (56% reduction) by the year 1990-91. Even after partition of Bihar, the area declined further, reaching an all time low at 18.49 thousand ha during 2017-18 (AICRPP, 2019). Similar trend of decline has been noticed for all pulses in most states of NE plains except Jharkhand.

The negative impact of rice-wheat cropping system has now become visible. System productivity of most such cropping systems have declined in the Indian states of EGP. Pigeonpea which is protein-rich and densely packed with micronutrients such as Fe and Zn got slowly unavailable from the regular diet of low income people who have lesser access to animal source

Table 1: Pigeonpea area (000 ha) during the last five decades in North-East Plains[#]

Year	Uttar Pradesh	Bihar	Jharkhand	West Bengal
1970 -71	582.40	150.30	--	25.80
1980 -81	522.60	93.70	--	22.60
1990 -91	468.10	66.20	--	5.80
2000 -01*	406.60	43.70	23.50	8.90
2010 -11	344.00	36.00	104.00	2.00
2017 -18	282.00	18.49	193.68	4.50

*Jharkhand bifurcated from Bihar; [#]Source: AICRPP 2019)

of protein and micronutrients (Choudhary *et al.*, 2019). All these have created renewed interest to diversify the present day narrow cropping system to enhance system productivity, sustain soil health and alleviate micro-malnutrition by incorporating pigeonpea and other pulses in the cropping system.

Crop diversification through inclusion of pigeonpea

Agricultural crop diversification is an important stress relieving option for economic growth of farming community. As stated earlier, first Green Revolution supplanted the existing cropping system largely with rice-wheat system in majority of cultivated areas in both north-west and north-east plains (Dwivedi *et al.*, 2017). Crop diversification through inclusion of early pigeonpea has gained momentum in north-west plain. In the north-east plain, the diversification through pigeonpea in rice-wheat system has been facing challenges due to erratic monsoon. Early pigeonpea, which is usually planted from mid-May to mid-June, encounters waterlogging after the onset of monsoon normally from the last week of June. Heavy mortality of seedlings occurs due to excess soil moisture, and *Phytophthora* stem blight (PSB), making it completely a futile exercise (Choudhary *et al.*, 2011). Long-duration pigeonpea which is planted normally during July also faces similar limiting conditions. Although it is relatively tolerant to waterlogging, and has some degree of PSB tolerance, the seedling mortality may be substantial if the crop faces partial submergence for 4-5 days due to continuous rainfall. Under such a situation, even pigeonpea transplanting fails to maintain the desired plant population. This leaves no option but to delay the sowing time, and resort to post-rainy (September) plantings of pigeonpea if diversification is indispensable.

Research initiated on post-rainy (September) pigeonpea at ICAR RCER Patna

NE plains receive more than 70 cm rainfall after the onset of south-west monsoon during June-September every year. Since monsson starts to recede from mid-September, post-rainy planting may be adopted as an alternate approach to address the issue of waterlogging and crop diversification. However, the varieties should be selected on the basis of early seedling vigour, rapid growth, branching intensity, disease resistance (*Phytophthora* stem blight, sterility mosaic, *Fusarium* wilt and *Alternaria* leaf blight) and high yield potential (Choudhary and Kumar, 2019). Research conducted at the ICAR-RCER, Patna has shown that sowing of 'Pusa 9' during the second week of September after harvest of quality protein green cob maize provided more than 3.0 t/ha grain yield under zero tillage management condition following one weeding and one-two insecticide spray at 10 days' interval commencing from second fortnight of February. Similarly, pigeon pea cv. 'IPA 203' sown on September 20, 2018 also yielded more than 3.5 t/ha under conventional tillage management practices (N:P:K: 20:50:0; two weeding; one irrigation during second fortnight of December; spray of *imidacloroprid* @1mL/L water). These findings indicate that the system is agronomically feasible, economically highly remunerative and ecologically viable and sustainable. Besides, September arhar may be taken as one of the best alternative crops instead of growing Indian mustard/toria. Moreover, it may be suited to contingency crop planning under aberrant situation in upland ecology of NE plains (Choudhary and Kumar, 2019).

Table 2: Comparative mean performance of September planted pigeonpea cultivars

Character	Pusa 9 (Mean ± sd)	IPA 203 (Mean ± sd)
Plant height (cm)	182.3±10.15	190.4±10.6
Primary branches/plant (no.)	14.4±0.58	18.5±0.74
Secondary branches/plant (no.)	84.8±1.47	77.7±1.35
Pods/plant (no.)	135±12.88	115±10.97
Pod length (no.)	6.15±0.34	5.49±0.31
Seeds/pod (no.)	3.92±0.10	3.52±0.09
1000-grain weight (g)	122±5.59	132±6.05
Grain yield (kg/m^2)	0.38±0.03	0.55±0.04
Biological yield (kg/m^2)	1.78±0.08	2.02±0.09

Source: ICAR RCER, Patna; sd: standard deviation

Fig. 1A: September planted 'Pusa 9'

Fig. 1B: September planted 'IPA 203'

Fig. 1C : Pusa 9 in cropping system mode

Fig. 1: September pigeonpea: **A:**Pusa-9, **B:** IPA 203, and **C:** Pusa 9 under cropping system mode at ICAR-RCER, Patna

Production technology of post-rainy (September) Pigeonpea

Traditionally, pigeonpea was considered a low-input crop, and therefore, it did not receive much attention for development of improved production technology except in some nutritional requirement studies. With the establishment

Table 3: Pigeonpea varieties suitable for post-rainy season (September) planting in the NE plains

Variety	Pedigree	Salient features*
WB 20	Prabhat × B 517	An old pigeopea variety of medium duration; it is resistant to ALB, and suitable for pre-rabi cultivation
DA 11 (Sharad)	(Bahar × NPWR 15) × PS 16	Non-determinate, compact, medium late, white seeded, and resistant to ALB and SM disease
Pusa 9	UPAS 120 × 3673	Non-determinate, compact, medium late with oval shaped seed, resistant to ALB and SM disease, and suitable for September planting
NDA 99-6 (NDA 3)	ICP 8862 × ICP 11204	Non-determinate with semi-compact canopy, resistant to ALB, and suitable for pre-rabi sowing
IPA 203 (Prakash)	Bahar × AC 314-314	An iron rich -bio-fortified pigeonpea variety (Fe > 80 ppm); resistant to PSB, FW and SM disease; early vigour and rapid early growth make it suitable for September planting

*Modified after Choudhary and Nadarajan (2011), AICRPP (2019); ALB: *Alternaria* leaf blight, PSB: *Phtophthora* stem blight, FW: *Fusarium* wilt, SM: sterility mosaic

Table 4: Production technology of post-rany season (September) pigeonpea*

Planting time	1st fortnight of September (up to 20th September under Patna condition)
Seed rate	25-30 kg/ha
Spacing	45 cm ×10-15 cm
Varieties	Details of varieties are mentioned in Table 3
Fertilizer	20:40:20-30:15-20 kg NPKS/ha; Additionally 10 kg N/ha (22 kg urea) is applied at optimum moisture levels at 20-25 days after sowing (DAS)
Seed inoculation	*Rhizobium culture* @ one packet (250 g) for 10 kg seed
Irrigation	Required under moisture stress
Ridge planting	Minimizes seedling mortality due to excessive rain *induced* waterlogging
Weed management	Two hand weeding at 25/45 DAS or application of Pendimethalin @1.25 kg/ha during pre-emergence stage followed by one hand weeding at 25-30 DAS
Cropping system	Dual purpose maize (cob and green fodder) or fodder sorghum-pigeonpea
Disease management	Most destructive diseases are FW caused by *Fusarium udum*, SM transmitted by the mite, *Aceria cajani*, PSB caused by *Phytophthora dreshsleri* f.sp. *cajani* and ALB caused by *Alternaria alternata*. While FW and SM are widely prevalent in NE plains, ALB is a major problem in pre-*rabi* (post-rainy) pigeopea grown during September-April in North-Bihar, eastern UP and WB.
1. FW	• Growing resistant/tolerant varieties • Seed treatment with carbendizim+thiram (1g+2g/kg seed) and Trichoderma @10 g/kg of seed • Crop rotation with sorghum
2. SM	Growing resistant varieties
3. ALB	• Growing of resistant varieties • Foliar spraying of fungicides mencozeb@ 0.2%
4. PSB	Seed treatment with metalaxyl (3g/kg seed)+ridge sowing and growing resistant varieties
Pest management	Gram pod borer (*Helicoverpa armigera*) and pod fly (*Melanagromyza obtusa*). First spray of insecticide (imidachloroprid @1mL/L or Indoxacarb @0.8 mL/L or Spinosad @0.4 mL/L of water) should be done when ETL is reached. ETL for pod borer: 1 larva/plant; for pod fly: 5% egg lying on pods. As a rule of thumb, the first spray of aforesaid insecticide should be done during 1st March, and the second after 12-15 days of the first spray.
Post harvest care	*Bruchids* (*Callosobruchus* spp.) are serious pests of pulses including pigeonpea during storage. Easy, simple and safe way to protect small quantities of grains is by smearing seed with 1% edible oils, i.e., mustard/coconut oil or by mixing 2% fine inert dust like caoline/lime powder with grain. For bulk storage, grains should be stored in air tight structures, i.e., container and by lot with aluminium phosphide @ 1 tablet/100 kg of seeds. Spraying of 1% fenvalerate on ground surface and walls also quite effectively minimize bruchids infestation.

*Modified from AICRPP (2019), PC Report, AICRP on Pigeonpea, Indian Institute of Pulses Research, Kanpur 208 024 (UP);
FW: *Fusarium* wilt, PSB: *Phyto[phthora* stem blight,
SM: Sterility mosaic, ALB: *Alternaria* blight
ETL: Economic therehold level

of All India Coordinated Research Project on pulses in 1967, research for development of production technology got impetus, leading to identification of suitable sole/mixed cropping system involving varieties of different maturity duration in pigeonpea (Choudhary and Nadarajan, 2011). Matching production technologies for September pigeonpea have also been developed through experiments conducted at several locations including ICRISAT, and these have been refined and revalidated time and again. The details of varieties and production technology for September pigeonpea are given in Table 3 and Table 4, respectively.

Breeding Strategies

Pigeonpea, which is basically perennial in nature, is cultivated as an annual crop (Asthana, 2001). The wide adaptation of this species is associated with some significant changes in its phenology. This is a consequence of its sensitivity to photo-period and temperature (Hugh *et al.*, 1985). Pigeonpea is a quantitative short day plant, and it influences the induction of flowering irrespective of its time of sowing and growth period. Once the plants flower, its vegetative growth severely reduces or completely stops in a few genotypes; therefore, to optimize the biomass production in a unit cultivated area, its agronomy, especially plant population, needs to be altered.

The concept of post-rainy season pigeonpea is four decades old (Roy Shrama *et al.*, 1980). However, the varieties used for rainy season (*Kharif*) and post-rainy season (*pre-Rabi*) cultivation are largely the same; and there is no exclusive breeding programme to develop high yielding cultivars for specific adaptation to post-rainy season. Across the pre-Rabi pigeonpea growing areas, there appears a large variation in the varieties grown, sowing time (late August to September end), and cultural practices. The planting time depends on the factors like receding monsoon and receding time of flooded water, drainage facilities, and soil type. The variations due to cultivars and sowing time thus lead to a large *cultivar* × *agronomy* × *environment* × *year* interactions, resulting in unpredictable performance of cultivars over the years. To overcome this constraint, there is a need to develop a well-structured breeding programme. Saxena *et al.* (1981) demonstrated that the estimates of genetic parameters (which determine the genetic gain and decide breeding strategies) differ grossly in the two planting dates, spaced by over one month. Byth *et al.* (1981), while assessing various breeding methods in pigeonpea, strongly recommended that to develop a variety for a given system, the selection of single plants and progeny bulks should be done in the same environment (i.e., spacing, planting time, irrigation and fertilizer). This will enhance the breeding value of the selections.

In the post-rainy sowings, the plant phenology changes drastically (Fig. 2A). In breeding, the traits with high heritability should be given priority. These include early vigour, rapid seedling growth, large number of primary (18-

20) and secondary (80-85) branches, non-determinate growth habit, large pod size (Fig. 2B) with 5-6 seeds/pod, and large seed size (12 -14 g/100 seeds) besides high seed purity and multiple disease resistance including ALB resistance. Since high plant density is desirable for post-rainy season planting, the breeding objective should include developing cultivars with a high degree of tolerance to shading and crowding stress (Saxena *et al.,* 2020). The stability of the performance can be enhanced by introducing/ increasing homeostasis in the cultivars, and this can be achieved by cultivating composite population (Khan, 1973), heterogeneous cultivars (Choudhary *et al.,* 2018), hybrids (Saxena *et al.,* 2018a) or sybrids (Saxena, 2020).

Fig. 2A: Effect of sowing date on plant phenology (**Source:** KB Saxena, ICRISAT)

CONCLUSION

Continued adoption of rice-wheat cropping system has many adverse effects. These are visible in terms of human health, soil health and environmental health. Introduction, adoption and acceptance of new varieties as well as new and upcoming production technologies can potentially change the aforesaid scenario. There is a need to identify cropping systems that may suit to a range of environments and farmers' income and preferences. Said in another way, cultivation cost of cereal-based production system has been higher than post-rainy (September) planted pigeonpea-based system. In NE plains, significantly highest system annual productivity has been recorded for maize cob – pigeonpea (September planted) system (ICAR RCER, 2019). The system registered maximum gross income and benefit-cost ratio (Rs.319215/ha and BCR 3.75). Hence promotion and adoption of pre-rabi pigenpea-based cropping system is agronomically feasible, economically highly remunerative and ecologically viable and sustainable. Besides, post-rainy pigeonpea may be taken as one of the best alternative crops instead of growing Indian mustard/toria. Moreover, it may be suited to contingency crop planning in aberrant situation in upland ecology of NE plains.

Fig. 2B: A large podded September sown pigeonpea at ICRISAT (**Source:** KB Saxena, ICRISAT)

ACKNOLEDGEMENT

Authors are grateful to partner institutions and researchers who have contributed to pigeonpea research. Thanks are also due to the Director, ICAR RCER, Patna for providing facilities and support.

CONFLICTS OF INTEREST

The authors declare no conflict of interest with other researchers and/or organizations working on same or related aspects.

REFERENCES

AICRPP. 2019. Project Coordinator's Report. All India Coordinated Research Project on Pigeonpea, Indian Institute of Pulses Research, Kanpur, India, Pp. 22–56.

Arumugam M, Pillai A, Chandran J, Chaudhary S, Mishra BK, Magadum SK, Gandhi V, Verma N, Singh N, Vanniyarajan C, Vathy T, Singh AK and Khan YJ. 2018. DG (RG) 55- High yielding short duration dwarf line of pigeonpea. *Journal of AgriSearch* **5** (1):5-7.

Asthana AN. 2001. Pigeonpea. In: VL Chopra (Ed), Breeding Field Crops, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, Pp. 281-304.

Byth DE, Wallis ES and Saxena KB. 1981. Adaptation and breeding strategies for pigeonpea. In: *Proc. Int. Workshop on Pigeonpeas*, Vol. 1, International Crops Research Institute for the Semi-Arid Tropics, Patancheru, A.P. India, Pages 450-465.

Choudhary AK and Kumar Rakesh. 2019. September arhar holds promise in north-east plains. *ICAR RCER News* **11** (1): 2.

Choudhary AK and Nadarajan N. 2011. Breeding improved cultivars of pigeonpea in India. Indian Institute of Pulses Research, Kanpur, India.

Choudhary AK, Mishra, JS, Kumar Ujjwal, Singh IS and Bhatt BP. 2018. Sustainable crop intensification through grain legumes for nutritional security in Eastern Gangetic Plains. Published in the *Abstract Proceedings* of an International Conference on *Sustainability of Smallholder Agriculture in Developing Countries under Changing Climatic Scenario* organized by The Society of Agricultural Professionals, Kanpur, India at Chandra Shekhar Azad University of Agriculture & Technology, Kanpur, India during February 14-17, 2018 Kanpur, India, Pp: 131.

Choudhary AK, Sultana R, Pratap Aditya, Nadarajan N and Jha UC.

2011. Breeding for abiotic stresses in pigeonpea. Journal of Food Legumes 24 (3): 165-174.

Choudhary AK. 2011. Effects of pollination control in pigeonpea and their implication. *Journal of Food Legumes* **24**: 50-53.

Choudhary AK. 2019. Improving the content and bioavailability of Fe and Zn in pulses for alleviating micronutrient malnutrition. Published in *Abstract cum Souvenir* of a National Seminar on *Recent Advances in Agriculture for Sustainable Rural Development (RAASRD 2019)* held on March 15-17, 2019 at VKSCOA, Dumaron (BAU, Sabour), Buxar, Bihar, Pp. 76-79.

Dwivedi SL, van Bueren ETL, Ceccarelli S, Grando S, Upadhyaya HD and Ortiz O. 2017. Diversifying food systems in pursuit of sustainable food production and healthy diets. *Trends in Plant Sciences* 22:843-856.

Hugh G Mcpherson, Ian J Warrington and Helen L Turnbull. 1985. The Effects of temperature and day length on the rate of development of pigeonpea. *Annals of Botany* **56:** 597-611.

ICAR RCER. 2019. Annual Report, ICAR Research Complex for Eastern Region, Patna 800 014 (Bihar), India, Pp. 35.

Khan TN. 1973. A new approach to the breeding of pigeonpea (*Cajanus cajan* (L.) Millsp.): formation of composites. *Euphytica* **22**: 373-377.

Khan YJ, Chaudhary S, Prasad BN, Pillai A, Verma N, and Singh AK.2019. Role of Lanc like G protein-coupled receptor-2with BOP and BTB/POZ in stress tolerance and high yielding trait of Pigeonpea. *Journal of AgriSearch* **6** (3):105-112.

Kumar Jitendra, Choudhary AK, Gupta Debjyoti Sen and Kumar Shiv. 2019. Towards exploitation of adaptive traits for climate-resilient smart pulses. *International Journal of Molecular Sciences* 20 (12): 29-71

Roy Sharma RP, Thakur HC and Sharma HM. 1980. Pigeonpea as a rabi crop in India. In : *Proc. Intl. Workshop on Pigeonpeas,* Vol. 1. International Crops Research Institute for the Semi-Arid Tropics, Patancheru, A.P., India, Pp 26-36.

Saxena KB. 2020. SyBrid - a new breeding method for food legumes. *Intl. J. Sci. Res.* **9** (6): 199-200.

Saxena KB, Byth DE, Wallis ES and Dellacy I. 1981. Genetic analysis of a diallel cross of early-flowering pigeonpea lines. In: *Proc. Int. Workshop on Pigeonpeas*, Vol. 2, International Crops Research Institute for the Semi-Arid Tropics, Patancheru, A.P. India, Pp 81-87.

Saxena KB, Choudhary AK, Saxena RK and Chauhan YS. 2020. Can pigeonpea hybrids negotiate stresses better than inbred cultivars? *Breeding Science* (DOI: https://doi.org/10.1270/jsbbs.20015).

Saxena KB, Choudhary AK, Saxena RK and Varshney RK. 2018b. Breeding pigeonpea cultivars for intercropping: synthesis and strategies. *Breeding Science* **68**: 159–167.

Saxena KB, Sharma D and Vales MI. 2018a. Development and commercialization of CMS pigeonpea hybrids. *Plant Breeding Reviews* **41**: 103 - 167.

Saxena KB. 2008. Genetic improvement of pigeonpea – A review. *Tropical Plant Biology* **1** (2): 159-178.

Singh AK, Singh AK, Kumar R, Prakash V Sundaram PK and Yadav SK. 2017. Indian Cereals Saga: Standpoint and Way Forward. *Journal of AgriSearch* **4** (1): 1-10.

Singh AK, Singh SS, Prakash V, Kumar S and Dwivedi SK.2015. Pulses Production in India: Present Status, Bottleneck and Way Forward. *Journal of AgriSearch* **2** (2): 75-83.

Citation:

Choudhary AK, Kumar Rakesh, Saxena KB and Singh AK. 2020. Post-rainy season pigeonpea holds promise for the diversification of cropping systems. *Journal of AgriSearch* **7**(3):115-120