Breeding for evolution of photo-insensitive pole type vegetable dolichos (*Lablab purpureus* L.) varieties to suit year round cultivation

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**Abstract**

Photosensitivity in pole types of vegetable dolichos is a major production constraint limiting its production to rabi. Presently, the pole type varieties are gaining popularity among farmers because of their higher yield levels. To accomplish the development of high yielding, pole type and photo-insensitive varieties, hybridization was done between (IC 556824-IPS-2 X Arka Swagath) and (IIHR 178 X Arka Swagath), wherein superior transgressive segregants from both the crosses were selected and crossed with Arka Amogh. Followed by pedigree method of breeding, the lines were advanced upto $F_7$ generation wherein six advanced breeding lines comprising of photo-insensitive trait, high yield and promising pod characters were selected and evaluated using pole type check varieties during both kharif and rabi for three years in succession from 2015-2017. All the advanced breeding lines had normal flowering in both the seasons as well as outperformed the checks with yield ranging from 37.2 to 41.1 t/ha during kharif and 37.9 to 41.4 t/ha in rabi, whereas in checks yield was comparatively lower ranging from 15.2 to 26.3 t/ha and 17.4 to 26.7 t/ha during kharif and rabi respectively.

**Keywords**

Pole type, yield, photo-insensitive, kharif, hybridization.

**INTRODUCTION**

*Lablab purpureus* L. Sweet (2n = 22), one of the most ancient crops among cultivated plants is largely cultivated across the tropical regions of Asia and Africa (Rahman *et al.* 2002; Haque *et al.* 2003). In India it is mainly grown in the states of Maharashtra, Karnataka, Tamil Nadu, Andhra Pradesh, Uttar Pradesh and North Eastern states. Being a legume vegetable it is recognized as vital source of nutrients, rich in health provoking phytochemicals and equipped with wide spectrum of micronutrients that can have far-reaching impact on fulfilling nutritional and health demands of humankind (Biju *et al.* 2001; Messina, 2016). Botanical varieties of dolichos are categorized into two types viz., *Lablab purpureous* var. *typicus* and *Lablab purpureus* var. *lignosus* with the former cultivated for its soft, edible pods and consumed as a vegetable whereas the later with dry seeds is largely used as a pulse food. It is a multifaceted crop that can be utilized for vegetable, pulse and fodder purpose (Adebisi and Bosch, 2004). Despite its huge potential, the crop remains unexploited by both farmers and consumers owing to a variety of reasons that comprise of low yield coupled with longer duration, photosensitive nature of plants and distinctive consumer preferences. Although it is a drought tolerant crop cultivated in dry lands with sparse rainfall, the crop prefers relatively cool season for flowering that starts fruiting in winter due to its photosensitive nature strictly hampering the kharif cultivation (Savithe, 2008; Verma *et al.*, 2014). In India, both bush and pole varieties are grown on a commercial scale with the former being photo-insensitive and grown during both kharif and rabi wherein varieties like Arka Jay, Arka Vijay and Konkan Bhushan are popular but their yields are low with 10-12 t/ha. In disparity to this, pole type varieties are generally indeterminate, high yielding but lack of photo-insensitive trait that makes them absorb for kharif cultivation (Parmar *et al.* 2013). Nevertheless pole varieties such as Swarna Utkrisht, Pusa Early Prolific (PEP) and Arka Swagath with yield potential of 20-30 t/ha imparted with photo-insensitivity are available, there is yet tremendous scope for enhancement of yield in the pole type dolichos varieties. Since, India is
identified to be the centre of origin and primary centre of diversity for dolichos, wide range of variability for various characters especially the yield has been proclaimed that could be tapped for augmenting yield levels of pole dolichos varieties (Mahadevu and Byregowda, 2005; Nene, 2006; Upadhyay et al. 2011). Besides this, the consumer preference for dolichos varieties relies considerably with pod shape, size, colour, aroma and cooking quality. Although wide range of varieties in both bush and pole type dolichos are available for commercial cultivation in the market, many of them lack preferable sensory characteristics since breeding programmes rarely attempted towards incorporation of these traits, that often fetch poor market and less preferred by consumers (Shivachi et al. 2012). With this background, the present investigation is aimed towards the development of pole type, photo-insensitive, high yielding dolichos varieties that invariably suit for round the year cultivation and also ensemble the choices of different consumer segments.

MATERIALS AND METHODS
The present breeding programme aimed towards the development of high yielding, pole type, photo-insensitive dolichos varieties was started in 2007 at Indian Institute of Horticultural Research, Bengaluru, India (13.13° N, 77.49° E) located at an altitude of 890 m above the mean sea level. Parental lines used in the study comprised of Arka Swagath, IIHR178, IC 556824-IPS-2 (pole type, photo-insensitive genotypes) and Arka Amogh, high yielding photo-insensitive bush variety. Initially, the crosses were attempted separately between (IC 556824-IPS-2 X Arka Swagath) and (IIHR 178 X Arka Swagath) to generate F1 population. Superior transgressive segregants in F1 generation from both the crosses were further selected and crossed with Arka Amogh for imparting superior pod quality characteristics. Following pedigree method of breeding, the selected lines with high yield and superior pod quality characteristics were advanced upto F2 generation, wherein six high yielding lines with promising pod characters were selected during 2015. These advanced breeding lines were evaluated in Randomized block design with three replications using three pole varieties as checks viz., Arka Swagath (parental high yielding check), Pusa Early Prolific (PEP) and Swarna Utkrisht (non-parental high yielding checks) during kharif season and also flowering started from basal node. Further, high heritability coupled with genetic advance has been reported by Verma et al. (2014) that supports selection for trait is effective in dolichos breeding programmes. In connection to days to first pod maturity, variability in the lines ranged from 61.6 to 87.0 and in checks it was 61.7 to 83.5 days. This clearly illustrates that the significant differences exist between lines and checks for the two traits viz., days to 50% flowering and days to pod maturity and all the selected breeding lines flowered early and attained pod maturity in advance to the check varieties. Further, it is conspicuous that the selected advance breeding lines generated from the present study assimilated photo-insensitivity nature witnessed on the basis of flowering against the eccentric long day photoperiods. With respect to pod length and width, selected breeding lines had higher pod length ranging from 11.2 to 17.8 cm and width of 1.3 to 3.3 cm in comparison to checks with 10.6 to 11.2 cm and 1.3 to 2.0 cm of pod length and width respectively. In terms of pod length, the highest of 17.8 cm was observed in IIHR 15-21 followed by IIHR 15-15 with 17.5 cm and least of 10.6 cm was found in check Swarna Utkrisht. Similar trend was reported in case of pod width wherein IIHR 15-23 followed by IIHR 15-5 recorded the highest pod width of 3.3 cm and 3.0 cm respectively and the lowest was recorded by check PEP with 1.3 cm. The results obtained are in synchrony with the experimental findings of Magalingam et al. (2013), Parmar et al. (2013) and Peer et al. (2018) who reported a significant and wide range of variability with respect to various morphological traits that are indirectly governing the yield in dolichos bean.

Among traits directly governing yield such as 10 pod weight and the number of pods per plant, significant differences in mean values were observed between checks and selected advanced breeding lines. With respect to 10 pod weight, all the selected lines recorded significantly higher pod weight ranging from 80.3 to 180.3 g as compared to checks with 69.0 to 75.3 g. Highest pod weight of 180.3 g was recorded by IIHR 15-23 followed by IIHR 15-15 with 150.3 g. In addition to this, the number of pods per plant were on the highest side in IIHR 15-7 with 566.7 pods per

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Table 1. Mean of pod characters in advanced breeding lines and check varieties during offseason cultivation (kharif) from 2015-2017

| Sl. No. | Advanced breeding lines/checks | Pedigree | Days to 50% flowering | Days to pod maturity* | Pod length (cm) | Pod width (cm) | Pod weight (g) | No. of pods/plant | Pod shape | Pod color |
|---------|---------------------------------|----------|-----------------------|-----------------------|-----------------|----------------|----------------|-----------------|-----------|-----------|
| 1.      | IIHR 15-15 (IC 556824)-IPS-2 X (Arka Swagath)-IPS 15 | 47.7     | 64.7                  | 17.5                  | 2.1             | 150.3          | 325.0          | Flat, long slightly curved | DG        |
| 2.      | IIHR 15-5 (Arka Amogh X (IIHR 178)-IPS-5 | 53.0     | 67.0                  | 13.8                  | 3.0             | 140.7          | 321.7          | Medium long undulating with shining surface | G         |
| 3.      | IIHR 15-23 (IIHR 178) X (Arka Swagath)-IPS 23 | 48.0     | 64.7                  | 17.0                  | 3.3             | 180.3          | 263.3          | Flat, long, broad and thick | G         |
| 4.      | IIHR 15-21 (IIHR 178)-IPS 21 | 48.3     | 65.3                  | 17.8                  | 1.3             | 119.7          | 369.0          | Slender, long undulating | DG        |
| 5.      | IIHR 15-8 Arka Swagath X (IIHR 178)-IPS 8 | 46.7     | 66.7                  | 12.3                  | 2.2             | 120.7          | 387.7          | Flat, Medium long and slightly broad | G         |
| 6.      | IIHR 15-7 Arka Swagath X (IIHR 178)-IPS 7 | 43.7     | 61.7                  | 11.7                  | 1.7             | 80.3           | 556.7          | Pods dark green, similar to Arka Swagath | DG        |
| 7.      | Arka Swagath (PC) | -        | 52.7                  | 65.3                  | 11.2            | 1.6            | 75.3           | Pods light green and medium long | LG        |
| 8.      | Pusa Early Prolific (NC) | -        | 58.8                  | 75.5                  | 10.9            | 1.3            | 68.7           | Flat, medium long pods | DG        |
| 9.      | Swarna Utkrisht (NC) | -        | 63.5                  | 83.5                  | 13.1            | 2.2            | 71.7           | Flat, medium long pods | G         |

S.E.(m)±

|          |          |          |          |          |          |          |          |          |          |          |
|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| CD @ 5 % | -        | 2.73     | 3.27     | 1.43     | 0.27     | 5.71     | 31.43    | -        | -        | -        |
| CV %     | -        | 2.86     | 2.58     | 5.03     | 6.45     | 2.36     | 4.25     | -        | -        | -        |

*S.E.(m)±: Standard Error of Mean, CD: Coefficient of Deviation, CV: Coefficient of Variation

 plant and the lowest of 263.3 pods per plant were found in IIHR 15-23 among the breeding lines. Elsewhere, in the checks wide range of variability was recorded for the trait with 76.5 to 420.33 pods per plant and among the three checks used, Arka Swagath and PEP recorded the highest and lowest number pods per plant respectively. Specific to this trait, out of the six selected breeding lines, only one line IIHR 15-7 yielded more number of pods per plant than the parental check Arka Swagath whereas others had lower number of pods per plant than this check and ranged from 263.3 to 387.7. Nevertheless all the six lines recorded more number of pods per plant in examination to the other two non-parental checks. Although parental check is performing superior in relation to this trait, yield was steeping in breeding lines owing to their expansion in pod weight than the check varieties. The outcome obtained from this study is in harmony with the findings of Desai et al. (2003), Parmar et al. (2013), Magalingam et al. (2013) and Radhelal et al. (2018) who reported direct correlation and significant positive direct effects between pod weight and pod yield in dolichos bean. Consistent with the results, significant positive and direct correlation between pod length, pod width, pod weight and pods per plant with pod yield in vegetable dolichos has been reported by Gupta et al. (2017).

Further, the comparison of yield per se between checks and selected breeding lines based on the average of three years during kharif and rabi unveiled significant differences between checks and breeding lines with selected lines ascendant over the three check varieties (Table 3). Average pod yield based on mean of four years during kharif in selected lines ranged from 37.2 to 41.1 t/ha in selected lines, based on the average of six pickings and in checks it was significantly lower with 15.2 to 26.3 t/ha. Among the six advance breeding lines, the highest yield of 41.1 t/ha was reported in IIHR 15-15 followed by IIHR 15-23 with 40.4 t/ha (Table 2). In rabi, average yield over three years ranged from 37.9 to 41.4 t/ha and in checks the yield levels remained almost similar to mean yields recorded during kharif ranging from 17.4 to 26.7 t/ha. In conjunction to this, percent increase in yield over
Table 2. Mean pod yield (t/ha) of selected advanced breeding lines and checks during kharif and rabi from 2015-2017

| S. No. | Advanced breeding lines/ checks | Kharif | Rabi | Kharif | Rabi | Kharif | Rabi | Kharif | Rabi | Mean* Percent increase in yield over parental check |
|--------|---------------------------------|--------|------|--------|------|--------|------|--------|------|--------------------------------------------------|
| 1.     | IIHR 15-15                      | 41.1   | 41.4 | 39.9   | 41.9 | 40.9   | 40.9 | 40.7   | 41.4 | 54.7 55.2                                       |
| 2.     | IIHR 15-5                       | 37.6   | 38.6 | 37.7   | 39.3 | 37.5   | 39.1 | 37.6   | 39.0 | 43.2 46.1                                     |
| 3.     | IIHR 15-23                      | 39.2   | 40.2 | 39.0   | 40.7 | 40.2   | 40.7 | 39.5   | 40.5 | 50.2 51.9                                    |
| 4.     | IIHR 15-21                      | 36.6   | 38.1 | 37.1   | 38.7 | 37.0   | 37.0 | 36.9   | 37.9 | 40.4 42.1                                    |
| 5.     | IIHR 15-8                       | 38.5   | 40.3 | 38.8   | 40.8 | 39.2   | 39.1 | 38.8   | 40.1 | 47.8 50.1                                    |
| 6.     | IIHR 15-7                       | 37.0   | 38.3 | 36.8   | 38.7 | 37.4   | 38.8 | 37.1   | 38.6 | 41.1 44.6                                    |
| 7.     | Arka Swagath (PC)               | 26.6   | 26.5 | 26.3   | 26.7 | 25.9   | 26.8 | 26.3   | 26.7 | - -                                           |
| 8.     | Pusa Early Prolific (NC)        | 16.5   | 18.2 | 14.4   | 17.4 | 14.8   | 16.5 | 15.2   | 17.4 | - -                                           |
| 9.     | Swarna Utkrisht (NC)            | 24.6   | 22.4 | 23.4   | 25.8 | 21.9   | 24.6 | 23.3   | 24.3 | - -                                           |

*S.E.(m)± 0.82 0.84 1.04 0.86 0.99 1.13 - - -
Cd@5% 2.27 2.33 2.88 2.39 2.76 3.13 - - -
CV % 3.16 3.16 4.03 3.20 3.82 4.27 - - -

The parental check ranged from 42.5 to 57.5 t/ha during kharif and in rabi, it varied between 42.1 to 55.2 t/ha wherein the line IIHR 15-15 outyielded all other breeding lines inclusive of non-parental checks across both the seasons. The reason behind momentous improvement in yield in the breeding lines could be accounted to a blend of factors that include heterotic advantage, alterations in genetic architecture, photo-insensitivity and induction in flowering that started from the basal node of the plant. The results generated from the study are in congruity with the findings of Kambale et al. (2002), Patil and Lad (2007), Chattopadhyay and Dutta (2010) and Verma et al. (2014) who explored wide range of variability for various traits governing yield and also yield per se from their studies. As accentuated earlier consumer preferences for vegetable type dolichos diverge extensively based on sensory characters such as appearance, texture, taste and cooking quality of pods. Hence, the selections were made consciously before advancing breeding lines that befit the requirements of different consumer segments. The selected advanced breeding lines are not only contrasted for pod yield but also were distinct in terms of appearance and texture as indicated in table 1. In the present study, respondents had the highest preference for line IIHR 15-15 as apparent from its highest mean score of 95.6 and least of 91.5 was recorded in IIHR 15-8 (Table 3). Hence, all the breeding lines being morphologically distinct and heterogeneous, not only satisfy the specifications of different consumer segments but also assist the farmers to avoid mechanical mixtures at crop growth and harvest stages promoting pure crop stand.

These findings clearly illustrate that current breeding programme aimed towards the development of pole type varieties of dolichos suitable for round the year cultivation could successfully integrate photo-insensitive trait into the

Table 3. Mean evaluation scores for pod sensory characteristics and yield of selected breeding lines

| Sl. No. | Advanced breeding lines | Pod length | Pod colour | Taste | Texture | Cooking quality | Over all Acceptance | Pod yield | Total |
|---------|-------------------------|------------|------------|-------|---------|-----------------|---------------------|-----------|-------|
|         |                         | 10 points  | 10 points  | 10 points | 10 points | 10 points | 20 points | 30 points | 10 points | 100 points |
| 1.      | IIHR 15-15              | 9.5        | 9.3        | 9.5    | 9.4     | 9.2             | 19.4             | 29.3      | 95.6   |
| 2.      | IIHR 15-5               | 9.2        | 9.0        | 10.0   | 9.2     | 9.5             | 18.8             | 27.5      | 93.2   |
| 3.      | IIHR 15-23              | 9.4        | 9.8        | 9.6    | 9.2     | 9.6             | 19.0             | 28.0      | 94.6   |
| 4.      | IIHR 15-21              | 9.4        | 9.0        | 9.0    | 9.3     | 9.3             | 18.8             | 27.5      | 92.3   |
| 5.      | IIHR 15-8               | 9.1        | 9.3        | 10.0   | 9.0     | 9.3             | 17.6             | 27.2      | 91.5   |
| 6.      | IIHR 15-7               | 9.0        | 9.8        | 9.8    | 9.0     | 9.4             | 18.3             | 28.8      | 94.1   |

Scores obtained are mean values based on sample evaluation from 30 individual respondents.
selected lines as obvious from the results obtained. Further, the average yields realized from the advanced breeding lines during both kharif and rabi were exceedingly higher than all the popular checks used in the present study that make them highly amenable to utilize directly as varieties or as potential parents for future breeding programmes. Apart from this, all the selected breeding lines differed widely for sensory characteristics that gratify the needs of assorted consumer sections across the country. Hence, the selected lines would customarily appease the choice of divergent consumer sections and invariably encourage farmers to cultivate vegetable dolichos throughout the year.

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REFERENCES

Adebisi, A.A. and Bosch, C.H. 2004. Lablab purpureus (L.) Sweet. In: Plant resources of tropical Africa (PROTA), G.J.H. Grubbenn and O.A. Denton, (Eds.), PROTA Foundation: Wageningen/Backhuys: Leiden/CTA: Wageningen, The Netherlands, p. 343-348.

Biju, M.G., Prasanna, K.P. and Rajan, S. 2001. Genetic divergence in hyacinth bean. Veg. Sci., 28: 163-164.

 Chattopadhyay, A. and Dutta, S. 2010. Characterization and identification of selection indices of pole type dolichos bean. Veg. Crops Res. Bulletin, 73: 33-45. [Cross Ref]

Desai, S., Bendale B., Bhave, V.W., Madav, S.G. and Mehta, J.L. 2003. Heterosis for growth and developmental characters in lablab bean (Lablab purpureus L. Sweet). Res. Crops, 4(3): 366-372.

Gupta, M., Rao, K.P. and Rajwade, V.B. 2017. Correlation study of floral traits, yield and nutritional parameters in dolichos bean (Lablab purpureus L.) genotypes under Allahabad agro climatic zone. J. pharmacognysy and phytochemistry, 6(6): 1585-1591.

Haque, M.E., Rahman, M., Rahman, M.A., Roy, A.K. and Sikdar, B. 2003. Lablab bean based intercropping system in northwest region of Bangladesh. Pak. J. Biol. Sci., 6(10): 948-951. [Cross Ref]

Kambale, S.P., Harer, P.N., Lad, D.B., Bhor, T.J. and Bangar, N.D. 2002. Genetic variability and heritability studies in wall (Lablab purpureus (L.) Sweet var. typicus. Journal of Maharashtra Agricultural University, 27(1): 119-120.

Magalingam, V., Yassin, M. and Kumar, S.R. 2013. Genetic variability and character association in dolichos bean. SAARC J. Agri., 11(2): 161-171. [Cross Ref]

Mahadevu P. and Byregowda M. 2005. Genetic improvement of Dolichos bean (Lablab purpureus L.) through the use of exotic and indigenous germplasm. Indian J. Plant Genet. Resour., 18: 1-5.

Messina, M.J. 2016. Legumes and soybeans: Overview of their nutritional profiles and health effects. Asia Pacific J. Clinical Nutrition, 25(1): 1-17.

Nene, Y.L. 2006. Indian pulses through Millennia. Asian Agri. History, 10(3): 179-202.

Parmar, M., Singh, A.P., Dhillon, N.P.S. and Jamwal, M. 2013. Genetic variability of morphological and yield traits in Dolichos bean (Lablab purpureus L.). African J. Agric. Res., 8(12): 1022-1027. [Cross Ref]

Patil, S.B. and Lad, D.B. 2007. Variability studies in Wal (Lablab purpureus (L.) Sweet). Journal of Maharashta Agricultural University, 32(2): 296-297.

Peer, S.S., Reddy, P.S.S., Sadarunnisa, S., Reddy, D.S. and Pandravada, S.R. 2018. Genetic Variability and Hertibility for Yield and Yield Attributes in Field Bean (Lablab purpureus L.) Genotypes. Int. J. Curr. Microbiol. App. Sci., 7(3): 2131-2137. [Cross Ref]

Radhelal, D., Praveen, C., Ramesh, N.D., Anita, K. and Ankush, G. 2018. Path coefficient analysis study in dolichos bean (Lablab purpureus L.). Int. J. Chem. Studies, 6(4): 2494-2496.

Rahman, J., Newaz, M.A. and Islam, M.S. 2002. Combining ability analysis on edible pod yield in F2 diallele population of lablab bean (Lablab purpureus L.). J. Agric. Educ. Technol., 5(1&2): 33-36.

Savitha, B.N. 2008. Characterization of Avarne (Lablab purpureus L. Sweet) local collections for genetic variability. Orissa J. Horti., 36(2): 103-107.

Shivachi, A., Kinyua, M.G., Kiplagat, K.O., Kimurto, P.K. and Towett, B.K. 2012. Cooking time and sensory evaluation of selected Dolichos (Lablab purpureus) genotypes. African J. Food Sci. Tech., 3(7): 155-159.

Upadhayay, D., Mehta, N., Singh, J. and Sahu, M. 2011. Genetic divergence in dolichos bean (Dolichos lablab L.). Electronic Journal of Plant Breeding, 2(4): 552-554.

Verma, A.K., Uma Jyothi, K. and Dorajee Rao, A.V.D. 2014. Variability and character association studies in dolichos bean (Lablab purpureus L.) genotypes. Electronic Journal of Plant Breeding, 5(2): 272-276.