



Responses of EMS on growth and yield of French bean (*Phaseolus vulgaris*)

AJAY KUMAR¹ and T S DHILLON²

Punjab Agricultural University, Ludhiana 141 001, India

Received: 14 March 2019; Accepted: 11 July 2019

Key words: Ethyl methane sulphonate, French bean, Heat tolerance, Mutation frequency

French bean (*Phaseolus vulgaris* L.) is an important legume vegetable crop, belongs to family Fabaceae. It is highly self-pollinated crop. The genetic variability in French bean is limited due to which it is difficult to develop improved varieties through traditional breeding methods of crop improvement. Mutation breeding is the best method to increase genetic variability within short time in French bean as this crop showed high response towards mutagen. The major methods used in mutation breeding programme are irradiation with gamma rays, X-rays known as physical mutagen and treatment with ethyl methane sulphonate (EMS) and sodium azide known as chemical mutagen (Ahmad and Hakeem 2013). Tulmenneto (1990) reported that mutagen based research work in beans were carried out in 17 countries with the objective of developing varieties which possess resistance against diseases, having higher protein content, changed growth habits, higher productivity and yield. Most of the mutation work was carried out in China whereas in India, very limited work has been done in the improvement of this crop. Only one variety Pusa Parvati has been released through mutation breeding. In the present contexts, the attempts were made to identify useful variability of French bean with the help of chemical mutagen ethyl methane sulphonate.

A field experiment was conducted during 2017–18 at the Vegetable Research Farm, of Punjab Agricultural University, Ludhiana with two varieties of French bean, viz. Arka Suvidha and Falguni. Their seeds were treated by chemical mutagen ethyl methane sulphonate (EMS). The seed treatment was done firstly by soaking seeds in distilled water at room temperature for 8 h and then treatment with ethyl methane sulphonate (EMS) solution for 4 h followed by 1 h washing of the seeds under running tap water. For each treatment 100 seeds of each variety were used for

determination of lethal dose. After determination of LD₅₀ the one dose below LD₅₀ dose and one dose above LD₅₀ were used for experiment purposes. In the above experiment, three doses of ethyl methane sulphonate selected, viz. were 0.15%, 0.25% and 0.35%, respectively.

The M₁ generation seeds were sown in the field during first week of February 2017. All the surviving M₁ mutant plants were harvested separately at the maturity. The harvested seeds were sown in the next season 2018 to rise M₂ generation. Half of the M₂ generation seeds of individual M₁ harvested plants were sown in plant to progeny rows during first week of February 2018, while remaining half seed were sown in March 2018, so as to expose the reproductive phase at high temperature for screening of plants. The seeds of variety Arka Suvidha and Falguni were also grown along with M₂ generation in which several desirable mutant plants were identified for days to 50% flowering, number of pods per plants, green pod and seed yield per plant (g). The statistical analysis were performed by selecting several desirable plants in M₂ generation and their mean performance was compared with parent's plants using Fisher's t- test of significance. The frequency percentage of selected mutants in M₂ generation was observed in both varieties Arka Suvidha and Falguni by dividing the number of mutant selected in different ethyl methane sulphonate concentration to total number of plants observed and multiplying it by one hundred.

The seed germination percentage under laboratory conditions in Arka Suvidha was 89.0% with control and after treatment with EMS (0.15%, 0.25% and 0.35%) it was 74.0, 51.0 and 42.0%, respectively whereas in case of Falguni the seed germination percentage was 88.0% with control and after treatment with EMS @ (0.15, 0.25 and 0.35%) it was 72.0, 49.0 and 40.0% respectively. The seed germination percentage in all the concentrations of EMS i.e. 0.15, 0.25 and 0.35% was drastically reduced as compared to control due to inhibitory effect of increasing mutagen dose on the germination of seeds. Similar results showing decreased germination with increase in dose of mutagen were also observed by Datir *et al.* (2007), Kavithamani *et al.* (2008), Ariraman *et al.* (2014), More and Borker (2016), Dhanavel *et al.* (2008) and Patial *et al.* (2015) in French

¹District Extension Specialist (ajaykpau@gmail.com), Vegetable, University Seed Farm, Usman (Tarn Taran); ²Associate Director (tarsemdhillon@pau.edu), Seeds, Punjab Agricultural University, Ludhiana, India.

beans and pulses.

Identification of mutant plants in M₂ generation: The mean performance of different treatments of ethyl methane sulphonate (EMS) and control in Arka Suvidha and Falguni in M₂ generation is presented in Table 1. The mutant plants were significantly different from control for various yield and its related traits during February and March sown crop. The mean days to 50% flowering of mutant plants in Arka Suvidha during February sown crop was 39.5 for 0.15% EMS, 39.7 for 0.25% EMS, 40.5 for 0.35% EMS and for control, it was 45.6, respectively. During March sown crop mean was 38.4 for 0.15% EMS, 38.6 for 0.25% EMS and 39.4 for 0.35% EMS and for control, it was 44.5, respectively. In Falguni during February sown crop the mean days to 50% flowering of mutant plants was 38.4 for 0.15% EMS, 38.5 for 0.25% EMS and 39.6 for 0.35% EMS and for control it was 44.4, respectively. During March sown crop mean was 37.6 for 0.15% EMS, 37.7 for 0.25% EMS and 38.5 for 0.35% EMS and for control, it was 43.6, respectively. In both the varieties mutants were early as compared to control.

The mean number of pods per plants of mutant plants in Arka Suvidha during February sown crop was 25.0 for control and it was 32.0 for 0.15% EMS, 31.0 for 0.25% EMS and 30.0 for 0.35% EMS respectively. In case of March sown crop the mean for control was 15.0 while it was 22.5 for 0.15% EMS, 21.0 for 0.25% EMS and 20.0 for 0.35% EMS, respectively. In Falguni during February sown crop, the number of pods per plants showed mean of 19.0 for control and it was 25.5 for 0.15% EMS, 25.0 for 0.25% EMS and 24.0 for 0.35% EMS respectively. During March sown crop the mean for control was 14.0 while it was 20.0 for 0.15% EMS, 19.0 for 0.25% EMS and 18.0 for 0.35% EMS, respectively. In both the varieties mutants showed higher number of pods as compared to control.

The mean green pod yield per plant of mutant plants in Arka Suvidha during February sown crop was 90.0 for control and it was 96.0 for 0.15% EMS, 98.0 for 0.25% EMS and 95.0 for 0.35% EMS respectively. In case of March

sown crop the mean was 50.0 for control while it was 56.0 for 0.15% EMS, 57.5 for 0.25% EMS and 55.0 for 0.35% EMS respectively. In Falguni during February sown crop, the mean green pod yield per plant of mutant plants for control was 85.0 while it was 92.0 for 0.15% EMS, 93.5 for 0.25% EMS and 90.0 for 0.35% EMS, respectively. During March sown crop, the mean for control was 48.0 while it was 55.0 for 0.15% EMS, 55.5 for 0.25% EMS and 53.0 for 0.35% EMS, respectively.

The mean seed yield per plant of mutant plants in Arka Suvidha during February sown crop was 17.0 for control and it was 23.5 for 0.15% EMS, 24.5 for 0.25% EMS and 22.0 for 0.35% EMS, respectively. In case of March sown crop the mean was 12.0 while it was 19.5 for 0.15% EMS, 20.0 for 0.25% EMS and 18.0 for 0.35% EMS, respectively. In Falguni during February sown crop the seed yield per plant of mutant plant for control was 16.0 and it was 22.0 for 0.15% EMS, 22.5 for 0.25% EMS and 21.0 for 0.35% EMS, respectively. During March sown crop, the mean for control was 8.0 and it was 15.5 for 0.15% EMS, 16.0 for 0.25% EMS and 13.0 for 0.35% EMS, respectively. In both the varieties mutants produces higher green pod and seed yield as compared to control. Kashid (2013) studied mutagenic effectiveness of ethyl methane sulphonate and sodium azide on Chickpea (*Cicer arietinum* L.) and obtained several desirable mutants showing earliness, higher pods per plant and seed yield per plant by treatment with both mutants as compared with control.

Frequency (%) of selected mutant plant in M₂ generation: The best ethyl methane sulphonate (EMS) concentration of a trait was selected based on frequency percentage of selected mutant plants in M₂ generation (Table 2). In Arka Suvidha during February and March sown crop, at 0.15% EMS concentration, the maximum frequency of mutant plant was observed for days to 50% flowering (1.58% and 1.25%), number of pods per plant (1.50% and 1.16%) and seed yield per plant (1.25% and 1.00%). The least frequency of selected mutants was observed in higher concentration of 0.35% EMS for days

Table 1 Mean performance of different treatments of EMS and control in M₂ generation of French bean during February and March 2018 sown crop for different characters

Variety	EMS (%)	Days to 50% flowering		No. of pods per plant		Green pod yield per plant (g)		Seed yield per plant (g)	
		February Mean	March Mean	February Mean	March Mean	February Mean	March Mean	February Mean	March Mean
Arka Suvidha	0.15	39.5*	38.4*	32.0*	22.5*	96.0*	56.0*	23.5*	19.5*
	0.25	39.7*	38.6*	31.0*	21.0*	98.0*	57.5*	24.5*	20.0*
	0.35	40.5*	39.4*	30.0*	20.0*	95.0*	55.0*	22.0*	18.0*
	Control	45.6	44.5	25.0	15.0	90.0	50.0*	17.0	12.0
Falguni	0.15	38.4*	37.6*	25.5*	20.0*	92.0*	55.0*	22.0*	15.5*
	0.25	38.5*	37.7*	25.0*	19.0*	93.5*	55.5*	22.5*	16.0*
	0.35	39.6*	38.5*	24.0*	18.0*	90.0	53.0*	21.0*	13.0*
	Control	44.4	43.6	19.0	14.0	85.0	48.0	16.0	8.0

*Significant difference at 5%

Table 2 Frequency (%) of selected mutant in M₂ generation for Arka Suvidha and Falguni during February and March 2018 sown crop for different characters

Season	EMS (%)	No. of plants observed		Days to 50% flowering		No. of pods per plant		Seed yield per plant (g)	
		Arka Suvidha	Falguni	Arka Suvidha	Falguni	Arka Suvidha	Falguni	Arka Suvidha	Falguni
February	0.15	1200	1100	1.58	1.18	1.50	1.45	1.25	1.18
	0.25	800	700	1.50	1.14	1.25	1.28	1.13	1.00
	0.35	700	650	1.29	0.92	1.14	1.07	0.71	0.61
March	0.15	600	550	1.25	1.27	1.16	1.41	1.00	1.09
	0.25	400	350	1.00	1.14	1.00	1.14	1.00	1.14
	0.35	350	300	0.86	1.00	1.12	1.00	0.86	0.66

to 50% flowering (1.29% and 0.86%), number of pods per plant (1.14% and 1.12%) and seed yield per plant (0.71% and 0.86%), respectively.

In Falguni during February and March sown crop, at 0.15% EMS concentration, the maximum frequency of mutant plant was observed days to 50% flowering (1.18% and 1.27%), number of pods per plant (1.45% and 1.41%) and seed yield per plant (1.18% and 1.09%). The least frequency of selected mutants was observed in 0.35% EMS concentration for days to 50% flowering (0.92% and 1.00%), number of pods per plant (1.07% and 1.00%) and seed yield per plant (0.61% and 0.66%) respectively. Similar observation of mutation frequency was observed by Dhanavel *et al.* (2008), Satpute and Fultambkar (2012), Kulkarni and Mogle (2013), Mangaiyarkarasi *et al.* (2014) and Kashid and More (2016) in French bean and pulses. The above findings clearly indicated that mutant plants for important traits were selected by using lower concentration of EMS (0.15%) and this concentration can be effectively used for inducing maximum variability in French bean.

SUMMARY

An experiment was conducted during 2017–18, to find out the effect of EMS on growth and yield of French bean. The germination percentage in M₁ generation decreased with the increased in concentration of EMS both in laboratory and field conditions. The varieties Arka Suvidha and Falguni produced several heat tolerant mutants during February and March, sown for days to flowering, number of pods per plant and seed yield per plant. The maximum numbers of mutants were observed in lower EMS concentration (0.15%) during February and March as compared to higher EMS concentration (0.25 and 0.35%), thus application of lower concentration of EMS has been recommended for crop improvement purposes in French bean through mutation breeding.

REFERENCES

Ahmad P and Hakeem K R. 2013. *Crop Improvement: New Approaches and Modern Techniques*. Springer Publisher,

New York.

- Ariraman M, Gnanamurthy S, Dhanavel D, Bharathi T and Murugan S. 2014. Mutagenic effect on seed germination, seedling growth and seedling survival of pigeon pea. *International Letters Nature Science* **21**: 41–49.
- Datir S S, Dhupal K N and Pandey R N. 2007. Gamma radiation and EMS induced variation in seed germination and plant survival in horse gram. *Journal of Arid Legumes* **4**: 15–17.
- Dhanavel D, Pavadai P, Mullainathan L, Mohana D, Raju G, Girija M and Thilagavathi C. 2008. Effectiveness and efficiency of chemical mutagens in cowpea. *African Journal of Biotechnology* **7**: 4116–17.
- Kashid N G. 2013. Mutagenic Effect of Ethyl Methane Sulphonate and Sodium Azide on Pod Characters in Chickpea (*Cicer arietinum* L.). *International Journal of Science and Research* **5**: 1535–37
- Kashid N G and More S B. 2016. Mutagenic effectiveness and efficiency of Ethyl methane sulphonate and Sodium azide in chickpea (*Cicer arietinum* L.). *International Journal of Advanced Research in Biological Sciences* **3**: 64–68
- Kavithamani D A, Kalamani C Vanniarajan and Uma D. 2008. Mutagenic effectiveness and efficiency of gamma rays and EMS in soybean. *Madras Agricultural Journal* **95**: 448–51
- Kulkarni G B and Mogle U P. 2013. Effects of mutagen on chlorophyll mutation in horse gram. *Bioscience Discovery* **4**: 214–19.
- Mangaiyarkarasi R, Girija M and Gnanamurthy S. 2014. Mutagenic effectiveness and efficiency of gamma rays and ethyl methane sulphonate in *Catharanthus roseus*. *International Journal of Current Microbial Applied Science* **3**: 881–89.
- More A D and Borkar A T. 2016. Mutagenic Effectiveness and Efficiency of Gamma Rays and EMS in *Phaseolus vulgaris* L. *International Journal of Current Microbial Applied Science* **5**: 544–54
- Patil M, Thakur S R and Singh K P. 2015. Comparative mutagenic effectiveness and efficiency of physical and chemical mutagen and induced variability in rice bean (*Vigna umbellata* Thunb, Ohwi and Ohashi). *Legume Research* **38**: 30–36
- Satpute R A and Fultambkar R V. 2012. Mutagenic effectiveness and efficiency of gamma rays and EMS in soybean (*Glycine max* L.). *Current Botany* **3**: 18–20
- Tulmenneto A. 1990. Genetic improvement of beans (*Phaseolus vulgaris* L.) through mutation breeding. *Genetic Improvement of Pulse crops* **7**: 296–27.