# Response to selection in early segregating generation in fenugreek (*Trigonella foenum-graecum* L.)

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## Abstract

**Selected seven $F_4$ progeny families and the same number of corresponding $F_3$ parent families were evaluated in paired rows in compact family block design with three replications, for primary branches per plant, pods per plant and seed per pod as an independent selection criterion in fenugreek. Out of the three selection criterion, highest realized selection response in percentage was recorded for pods per plant (34.76%), and was followed by that for primary branches per plant and seeds per pod. The highest realized correlated response to selection for seed yield per plant was recorded under the selection criterion, primary branches per plant (25.89%), followed by that under selection criterion pods per plant (24.84%) and under seeds per pod (14.99%). Thus the selection criterion, primary branches per plant and pods per plant were more efficient than the seeds per pod.**

**Key words** : Fenugreek, response to selection, correlated response, early generation selection

## Introduction

Fenugreek (*Trigonella foenum-graecum* L.) is an annual autogamous crop [1]. The area under fenugreek in the India is 89420 ha with the production of 93310 tones. The average productivity of this crop in India is 1004 kg/ha [2]. Fenugreek has got low productivity due to several reasons such as its cultivation on marginal lands with poor fertility, lack of improved varieties, susceptibility to diseases like powdery mildew, wilt, root rot, and poor adoption of improved agronomic package and practices. In spite of multifarious importance of this crop, the attempts to improve its genetic potential are limited primarily because of narrow range of genetic variability in respect of various characters [3]. Once a cross is made, it is important to evaluate its genetic potential in early segregating generations such as $F_2$ and $F_3$ in order to use the available resources in an efficient manner [4]. Early generation selection has been advocated since long in order to increase the possibility of selecting the desirable plants in later generations [4-6]. There is no report on effectiveness of early generation selection and on evaluation of relative potential of primary seed yield components as selection criterion in early segregating generation for improvement in seed yield in fenugreek. In fenugreek the characters, primary branches per plant, pods per plant and seeds per pod have been reported to have high heritability [7, 8]. Thus, in the present investigation an attempt was made to evaluate the potential of pods per plant, primary branches per plants and seeds per pod as independent selection parameters in early segregating generation ($F_3$ generation) of a fenugreek cross *viz*., UM-305xRMt-143.

## Materials and methods

The material for the investigation consisted of 21 $F_3$ families and the 21 selected $F_4$ families of a fenugreek cross *viz*., U.M -305 x RMt-143. $F_2$ generation plants of several crosses among diverse parents were evaluated during *rabi* 1998-99. The parent UM-305 has got determinate growth habit along with resistance to powdery mildew while RMt-143 has got indeterminate growth habit [9]. All the $F_2$ plants were harvested individually to get $F_3$ families. Out of the total $F_3$ families of the cross (UM- 305 x RMt-143), 21 randomly selected families were evaluated along with parents and check variety (RMt-1) in RBD with 3 replication during *rabi* 1999-2000. Only half quantity of seed of each $F_3$ family was used in this experiment and remainder half seed

was saved for further evaluation. Thus, in $F_3$ generation in total 1890 $F_3$ plants were evaluated in this experiment. Observations on seed yield and it components were recorded on 5 randomly sampled plants in each of the 21 families in each of the three replications. Thus for each family 15 plants were sampled over 3 replications. Out of the total $F_3$ sampled plants (21 x 15 = 315 plants), seven superior plants from superior $F_3$ families were selected with selection intensity of 2.3 on the basis of each of the three seed yield components, *viz.,* primary branches per plant, pods per plant and seeds per pod. The culling level for primary branches per plant, pods per plants and seed per pods were kept 7, 64 and 17, respectively. These seven superior plants having higher value than the culling level for each of these three yield components were selected from the 7 $F_3$ families and harvested individually to get 7 selected $F_4$ families. Thus, under each component character (selection criterion) there were 7 F4 generation selected families and corresponding 7 $F_3$ families. In total there were 21 selected $F_4$ families and 21 parental $F_3$ families. During *rabi* 2003-2004 the selected 21 $F_4$ progeny families and the corresponding 21 $F_3$ parental families (remnant seeds of $F_3$ families) were evaluated in paired rows in Compact Family Block Design with 3 replications [10]. The single row plots were of 3 m length. The row to row and plant to plant spacing of 30 cm and 10 cm, respectively was kept. The observations were recorded on 10 randomly selected plants in each of the $F_3$ families and each of the $F_4$ families in each replication for plant height, primary branches per plant, pods per plant, pod length, seeds per pod, 100-seed weight and seed yield per plant. The selection parameters *viz.* realized selection response, realized correlated response, realized heritability in $F_4$, realized generalized response and coefficient of determinant of selection response in $F_4$ were estimated under each of the selection criterion as per Sharma [10]. In $F_4$ generation families under each of the selection criterion two superior $F_4$ families were selected on the basis of superior mean value with respects all the observed characters with selection intensity of 1.05 and selection parameters *viz*., realized selection differential in $F_4$ and predicted response to selection, predicted generalized response, predicted correlated response for seed yield/plant, predicted heritability and predicted selection differential in $F_5$ were estimated as per procedure outlined by Sharma [10].

## Results and discussion

Out of the three selection criteria *viz.,* primary branches per plant, pods per plant and seeds per pod, highest realized selection response in percentage was recorded for pods per plant (34.76%), followed by primary branches per plant (30.39%) and seeds per pod (12.11%) (Tables 1, 2 & 3). So far, no work on direct selection response has been reported in fenugreek, but similar findings on direct selection have been reported in soybean [6] and chickpea [11]. The highest realized correlated response to selection for seed yield per plant was recorded under the selection criterion primary branches per plant (25.59%) (Table 1) followed by keeping other selection criterion considering pods per plant (24.84%) (Table 2) and seeds per pod (14.99%) (Table 3). Similar results have also been reported in chickpea [11] as well as in rice [12]. Comparison of the rgR values for the three selection criteria indicated that primary branches per plant as selection criterion had the highest rgR which further stated relatively high effectiveness of primary branches per plant as a good selection criterion. The rgR values in lentil [13] have also pointed out primary branches per plant as a good selection criterion.

The realized heritabilities indicate the relative effectiveness of component characters as selection criterion [10]. This parameter was estimated for each of the three component characters used as selection criterion. The realized heritability estimate was highest for primary branches per plant (31.17%) which indicated relatively higher effectiveness of heritability estimate as selection criterion than the vdryetsgdf other two selection criteria. Similar results were reported by Vir and Gupta [13] in lentil. Rasmusson and Cannell [14] also estimated this parameter in barley.

Selection was again carried out in the $F_4$ generation families under each of the selection criterion by selecting two superior families on the basis of superior mean value with respect to all the observed characters with selection intensity of 1.055. The analysis of the parameters, rS in $F_4$, pR in $F_5$, pR per cent in $F_5$, pgR in $F_5$ generations and expected correlated response in $F_5$ generation for seed yield per plant under the selection criterion of primary branches revealed that in $F_4$ families the characters, plant height and primary branches per plant had high pR per cent and high pgR. However, plant height had negative predicted correlated response for seed yield per plant. Thus, further selection for primary branches per plant should be more effective among the *¥4* families under above mentioned selection criterion.

Considering pods per plant as selection criterion,

**Table 1.** Selection parameters for observed characters criterion in $F_4$ families using primary branches per plant as selection

| Characters | Realized selection response (rR) | Realized selection response in % rR(%) | Realized correlated response rCRy | Realized correlated response in % rCry(%) | Realized heritability in $F_4$ (rh²n) % | Realized generalized response (rgR) | Coefficient of determinant of selection response R(%) | Realized selection differential in $F_4$ (rS) | Predicted response in $F_5$ (pR) | Predicted response in % pR(%) | Predicted generalized response in $F_5$ (pgR) | Predicted CRy for seed yield in $F_5$ | Predicted heritability in $F_5$ (ph²n)% | Predicted selection differential in $F_5$ (pS) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Days to 50 % flowering | - | - | 0.866 | 1.386 | - | - | 0.860 | | | | | 0.6699 | | |
| Days to maturity | - | - | 0.525 | 0.429 | - | - | 3.6141 | | | | | -1.548 | | |
| Plant height (cm) | - | - | 5.428 | 17.64 | - | - | 73.23 | 5.041 | 15.01 | 48.80 | 0.877 | -0.380 | 83.18 | 18.05 |
| Number of primary branches | 1.52** | 30.39 | - | - | 31.17 | 0.718 | 30.04 | 0.8857 | 1.60 | 31.99 | 0.756 | 0.3434 | 71.7 | 2.237 |
| Number of pods per plant | - | - | 6.17** | 22.83 | - | - | 83.55 | 2.986 | 8.84 | 32.71 | 0.6930 | 1.7629 | 65.68 | 13.46 |
| Pod length (cm) | - | - | 0.397 | 5.050 | - | - | 97.81 | 0.442 | 0.760 | 9.67 | 0.672 | 0.6322 | 63.7 | 1.193 |
| Seeds per pod | - | - | 0.7447 | 4.996 | - | - | 97.99 | 1.755 | 1.4484 | 9.717 | 0.563 | 0.6097 | 53.4 | 2.710 |
| 100 seed weight (g) | - | - | 0.092** | 6.97 | - | - | 73.84 | 0.067 | 0.14 | 11.22 | 0.660 | 2.7956 | 62.62 | 0.238 |
| Seed yield per plant (g) | - | - | 1.066** | 25.59 | - | - | 1.22 | 0.713 | 1.23 | 29.68 | 0.553 | - | 52.4 | 2.35 |

*, ** Significant at 5 and 1% levels, respectively

**Table 2.** Selection parameters for observed characters in $F_4$ families following pods per plant as selection criterion

| Characters | Realized selection response (rR) | Realized selection response in % rR(%) | Realized correlated response rCRy | Realized correlated response in % rCry(%) | Realized heritability in $F_4$ (rh²n) % | Realized generalized response (rgR) | Coefficient of determinant of selection response R(%) | Realized selection differential in $F_4$ (rS) | Predicted response in $F_5$ (pR) | Predicted response in % pR(%) | Predicted generalized response in $F_5$ (pgR) | Predicted CRy for seed yield in $F_5$ | Predicted heritability in $F_5$ (ph²n)% | Predicted selection differential in $F_5$ (pS) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Days to 50% flowering | - | - | 0.8576 | 1.3821 | - | - | 10.360 | | | | | -0.3084 | | |
| Days to maturity | - | - | -1.14 | -0.942 | - | - | 5.933 | | | | | -0.5523 | | |
| Plant height (cm) | - | - | 1.779 | 6.247 | - | - | 87.26 | 4.13 | 9.77 | 34.32 | 0.7590 | 1.4259 | 71.95 | 13.58 |
| Number of primary branches | - | - | 0.80 | 17.06 | - | - | 54.24 | 0.785 | 1.19 | 25.34 | 0.589 | 0.3229 | 55.87 | 2.138 |
| Number of pods per plant | 10.40** | 34.76 | - | - | 28.98 | 0.667 | 81.71 | 4.14 | 9.28 | 30.99 | 0.594 | 0.9299 | 56.37 | 16.46 |
| Pod length (cm) | - | - | 0.52 | 6.73 | - | - | 35.71 | 0.463 | 0.56 | 7.21 | 0.554 | 0.1530 | 52.60 | 1.07 |
| Seeds per pod | - | - | -0.490 | 3.603 | - | - | 70.39 | 0.5304 | 0.8026 | 5.897 | 0.4770 | 0.3084 | 45.21 | 1.7744 |
| 100 seed weight (g) | - | - | 0.046 | 3.62 | - | - | 9436 | 0.053 | 0.183 | 14.29 | 0.0758 | 2.0530 | 71.00 | 0.255 |
| Seed yield per plant (g) | - | - | 1.02** | 24.849 | - | - | 74.89 | 0.5382 | 1.25 | 30.52 | 0.6158 | - | 58.3 | 2.149 |

*, ** Significant at 5 and 1% levels, respectively

**Table 3.** Selection parameters for observed characters in $F_4$ families using seeds per pod as selection criterion

| Characters | Realized selection response (rR) | Realized selection response in % rR(%) | Realized correlated response rCRy | Realized correlated response in % rCry(%) | Realized heritability in $F_4$ (rh²n) % | Realized generalized response (rgR) | Coefficient of determinant R(%) | Realized selection differential in $F_4$ (rS) | Predicted response in $F_5$ (pR) | Predictred response in % pR(%) | Predicted generalized response in $F_5$ (pgR) | Predicted CRy for seed yield in $F_5$ | Predicted heritability in $F_5$ (ph²n)% | Predicted selection differential in $F_5$ (pS) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Days to 50 % flowering | - | - | -0.237 | -0.3835 | - | - | 13.815 | - | | | | 1.1897 | | |
| Days to maturity | - | - | -1.310 | -1.063 | - | - | 151.085 | - | | | | 2.3378 | | |
| Plant height (cm) | - | - | 4.78 | 15.95 | - | - | 31.16 | 5.675 | 12.98 | 43.30 | 0.8514 | -1.2380 | 80.70 | 16.09 |
| Number of primary branches | - | - | 0.67 | 14.76 | - | - | 61.36 | 0.67 | 1.18 | 26.09 | 0.614 | 1.8032 | 58.00 | 2.03 |
| Number of pods per plant | - | - | 5.92** | 21.93 | - | - | 98.51 | 5.36 | 6.62 | 24.52 | 0.5406 | 2.3995 | 51.24 | 12.93 |
| Pod length (cm) | - | - | 0.53 | 6.78 | - | - | 39.11 | 0.39 | 0.686 | 8.74 | 0.81 | -0.2258 | 77.00 | 0.88 |
| Seeds per pod | 1.925** | 12.11 | - | - | 30.54 | 0.7019 | 38.18 | 0.6547 | 1.668 | 10.49 | 0.6081 | 1.8418 | 57.64 | 2.893 |
| 100 seed weight (g) | - | - | 0.089** | 6.72 | - | - | 54.19 | 0.060 | 0.128 | 9.63 | 0.60 | 0.5482 | 57.00 | 0.22 |
| Seed yield per plant (g) | - | - | 0.5926 | 14.99 | - | - | 38.54 | 0.6523 | 0.8069 | 20.41 | 0.4443 | - | 42.11 | 1.916 |

*, **Significant at 5 and 1% levels, respectively

high pR (in per cent) and high pgR were recorded for the characters like plant height and primary branches per plant. Also, predicted correlated response in seed yield per plant due to selection for plant height was the highest and positive. Correlated response for seed yield due to selection for primary branches per plant was also positive. This indicated that further selection for plant height and primary branches per plant should bring about more useful results in $F_4$ generation families under the selection criterion of pods per plant. Under the selection criterion seeds per pod, high pR(%) and high pgR were recorded for the characters, plant height and primary branches per plant. However, for plant height the expected correlated response*for seed yield per plant was negative. Therefore, keeping seeds per pod as selection criterion will necessitate further selection in the $F_4$ generation adopting primary branches per plant as selection criterion. Thus, under each of the selection criterion, selection for primary branches per plant in $F_4$ generation families would be highly effective.

High predicted heritability in narrow sense was estimated for plant height and primary branches per plant under the selection criterion of primary branches per plant. Similarly, high predicted heritability in narrow sense was also estimated for plant height and 100 seed weight under pods per plant as selection criterion. Following seeds per pod as selection criterion, high estimates of heritability in narrow sense were recorded for plant height and pod length. Therefore, under each of the selection criterion, plant height should also be used as selection criterion in $F_5$ generation. On the basis of results obtained in the present investigation it can be concluded that early generation selection in fenugreek considering primary braches per plant will form a firm basis for useful genetic gains. The results of the present investigation are in accordance to the results demonstrated in other crops too [7, 8].

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