Indian J. Genet., **48**(1): 103–106 (1988)

SELECTION INDICES FOR SEED YIELD IN INDIAN MUSTARD (*BRASSICA JUNCEA* (L.) CZERN & COSS). I. BASED ON PHYSIOLOGICAL ATTRIBUTES

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(Received: January 1, 1985; accepted: September 21, 1987)

ABSTRACT

Selection indices based on the relative importance of four physiological attributes were used in non-segregating populations of two crosses of Indian mustard, namely RH 30 × RC 781 and Prakash × RC 1425. It was observed that leaf area duration and leaf area index at reproductive phase, when selected simultaneously, resulted in the highest genetic gain in seed yield. Selection indices based on leaf area duration and leaf area index exhibited superiority over straight selection for yield in both crosses. However, leaf area duration combined with any other character satisfactorily improved the expected genetic gain in both crosses. The genotypes having persistent green leaves till physiological maturity reflected long leaf area duration, hence selection for this physiological attribute at this stage would be desirable for seed yield improvement in this crop.

Key words: Selection index, physiological attributes, genetic gain, relative efficiency, Indian mustard.

Direct selection for seed yield has been reported to be an ineffective criterion, as it is highly influenced by environmental fluctuations [1, 2]. Therefore, to ensure a predictable genetic gain in the improvement of yield as well as other characters, some kind of a balanced selection is usually required. The selection indices, based on several observations made on an individual, provide much valid selection criteria for this purpose [1]. In the present study, four important physiological attributes showing positive and significant association with seed yield [3] were considered for construction of suitable selection indices using all possible combinations among these attributes in Indian mustard.

MATERIALS AND METHODS

The phenotypic and genotypic variances and covariances were used for forming selection indices based on four physiological attributes, namely net assimilation rate (NAR), crop growth rate (CGR), leaf area duration (LAD), and leaf area index (LAI), which were calculated from the mean values for dry matter and leaf area recorded at five intervals in two different phases, i.e. vegetative and reproductive phases of plant growth. These observations were recorded on five competitive plants each in the nonsegregating genotypes (P_1, P_2 and F_1) of two important crosses of Indian mustard, namely, RH 30 × RC 781 and Prakash × RC 1425. The experimental material developed in 1979 and 1980 was sown in randomized block design with three replications during rabi (October-March) 1981-82 at Haryana Agricultural University, Hisar. Each entry was represented by 9-row

plot, 6 m long, with a spacing of 30 cm between and 15 cm within rows. The experiment was conducted under irrigated condition in loam soil applied with 80 kg N/ha as basal dose. The basis for identifying these physiological indices was their significant and positive association with seed yield.

Selection indices based on these attributes were constructed by the procedure of [4]. Seed yield per plant was included as one of the independent characters as suggested [5].

RESULTS AND DISCUSSION

The selection indices, expected genetic gain through straight selection genetic gain based on discriminant function, and their relative efficiency for physiological attributes, namely, NAR, CGR, LAD and LAI (all at reproductive phase) and seed yield in two crosses, viz., RH 30 × RC 781 and Prakash × RC 1425 are presented in Tables 1 and 2. Table 1 shows that for the cross RH 30×RC 781, the highest genetic gain of 140.5%

Table 1. Selection indices, genetic gain and relative efficiency of $\Delta G'$ over ΔG for different combinations of physiological traits in nonsegregating generations of cross RH 30 × RH 781

Selection index	ΔG	$\Delta G'$	Relative efficiency of $\Delta G'$ over ΔG, %
$0.599\,Y + 20.80\,X_1$	3.5	3.6	1.46
$0.328\,Y - 0.289\,X_2$	1.9	2.3	21.15
$0.710\,Y + 0.977\,X_3$	131.0	131.1	0.07
$0.552\,Y + 1.216\,X_4$	6.7	7.0	3.16
$-29.933\,X_1 + 0.059\,X_2$	1.6	1.1	−30.15
$-71.553\,X_1 + 0{,}985\,X_3$	128.6	130.2	1.28
$-\ 2.479\,X_2 + 959\,X_4$	4.1	4.0	0.02
$1.814\,X_2 + 0.963\,X_3$	128.3	127.6	−0.52
$0.674\,X_2 + 0.940\,X_4$	4.0	4.1	0.91
$0.491\,X_3 + 20.022\,X_4$	132.7	140.5	5.86
$0.431\,Y + 16.506\,X_1 + 0.231\,X_2$	1.9	2.2	14.16
$0.934\,Y + 52.638\,X_1 + 0.788\,X_3$	131.0	118.8	−9.32
$-\ 0.031\,Y + 173.41\,X_1 + 2.377\,X_4$	6.7	7.4	10.12
$0.832\,Y + 1.385\,X_2 + 0.914\,X_3$	130.6	126.6	3.13
$0.154\,Y + 0.546\,X_2 + 1.342\,X_4$	5.7	6.3	11.92
$0.694\,Y + 0.247\,X_3 + 19.660\,X_4$	135.1	125.5	−7.10
$-47.220\,X_1 - 1.317\,X_2 + 0.880\,X_3$	128.7	123.0	−4.48
$-15.067\,X_1 + 0.313\,X_2 + 0.849\,X_4$	4.0	4.0	−0.75
$106.120\,X_1 + 0.349\,X_3 + 20.430\,X_4$	132.7	131.2	−1.18
$-\ 0.479\,X_2 + 0.237\,X_3 + 20.360\,X_4$	132.5	124.3	−6.13
$0.750\,Y + 47.052\,X_1 + 0.285\,X_2 + 1.004\,X_3$	130.7	133.1	1.86
$0.209\,Y + 10.884\,X_1 - 0.218\,X_2 + 1.378\,X_4$	15.7	6.3	11.45
$-\ 0.320\,Y + 359.420\,X_1 - 0.254\,X_3 + 22.090\,X_4$	135.1	126.5	−6.41
$-\ 0.405\,Y - 2.513\,X_2 + 0.308_3 + 21.420\,X_4$	134.8	132.5	−1.70
$26.641\,X_1 - 0.205\,X_2 + 0.482\,X_3 + 20.090\,X_4$	132.4	139.7	5.48
$0.047\,Y + 42.700\,X_1 - 1.246\,X_2 + 0.348\,X_3 + 20.798\,X_4$	134.8	136.2	1.01

Y— Seed yield, X_1— NAR (reproductive phase), X_2— CGR (reproductive phase), X_3— LAD (reproductive phase), X_4— LAI (reproductive phase), ΔG— expected genetic gain through straight selection, and $\Delta G'$— expected genetic gain through discriminant function.

followed by 130.2 and 127.6% was obtained when selection was simultaneously based on discriminant functions of two characters, e.g. LAD and LAI, NAR and LAD, and CGR and LAD, respectively. Combinations of three attributes at a time did not give additional gain. Appreciable gain (139.7%) was recorded when all the four physiological attributes, NAR, CGR, LAD and LAI, were considered together for selection at reproductive phase. This gain was, however, at par with the gain attained by taking only two characters, e.g. LAD and LAI. Interestingly, appreciable genetic gain (131.1%) was realised when selection for seed yield was based only on LAD at reproductive phase. The highest genetic gain (68.5%) through selection based on discriminant function was achieved by taking all the four physiological attributes at a time in the second cross, Prakash×RC 1425 (Table 2). This was followed by the net genetic gain (66.5%) obtained through the selection based on two characters, i.e. LAD and LAI (both at reproductive phase). The per cent relative efficiency in selection based on discriminant function over straight selection was 11.9 and 9.69, respectively.

Table 2. Selection indices, genetic gain and relative efficiency of $\Delta G'$ over ΔG for different combinations of physiological traits in nonsegregating generations of cross Prakash×RC 1425

Selection index	ΔG	$\Delta G'$	Relative efficiency of $\Delta G'$ over ΔG, %
$0.878\,Y + 4.915\,X_1$	4.9	4.9	0.01
$0.095\,Y - 0.190\,X_2$	0.7	1.3	89.69
$0.738\,Y + 0.935\,X_3$	56.3	55.0	−2.30
$0.868\,Y + 0.924\,X_4$	5.8	5.8	0.04
$0.813\,X_1 + 0.954\,X_3$	3.9	53.9	0.00
$-\ 5.2729\,X_1 + 0.767\,X_2$	57.0	57.1	0.29
$-\ 82.501\,X_1 + 0.858\,X_4$	3.6	4.3	21.83
$0.795\,X_2 + 0.985\,X_3$	57.5	57.6	0.10
$0.944\,X_2 + 0.942\,X_4$	5.3	5.3	0.00
$1.036\,X_3 + 0.108\,X_4$	60.6	66.5	9.69
$0.056\,Y + 20.805\,X_3 - 0.237\,X_2$	0.7	1.4	101.65
$0.569\,Y - 609.224\,X_1 - 0.730\,X_3$	56.2	56.6	0.56
$0.883\,Y + 86.567\,X_1 + 0.376\,X_4$	5.8	5.8	0.73
$-\ 0.924\,Y + -1.542\,X_2 + 0.976\,X_3$	56.5	56.6	0.19
$0.002\,Y - 0.307\,X_2 + 0.883\,X_4$	2.9	3.5	206.64
$0.705\,Y + 1.020\,X_3 + 0.734\,X_4$	59.9	60.6	1.19
$-668.343\,Y + 1.348\,X_2 + 0.656\,X_3$	57.6	56.4	−2.13
$-102.956\,X_1 + 0.962\,X_2 + 0.290\,X_4$	5.3	5.4	1.15
$-593.727\,X_1 + 0.754\,X_3 - 0.075\,X_4$	60.6	59.3	−2.24
$0.662\,X_2 + 1.121\,X_3 + 0.742\,X_4$	61.2	21.9	1.15
$-\ 1.100\,Y - 7112.19\,X_1 - 1.194\,X_2 + 1.158\,X_3$	56.5	56.8	0.51
$-\ 0.047\,Y + 35.492\,X_1 - 0.378\,Y_2 + 1.197\,X_4$	2.9	3.5	21.19
$0.562\,Y - 675.182\,X_1 - 0.843\,X_3 + 0.643\,X_4$	59.9	63.6	6.10
$-\ 0.960\,Y - 1.835\,X_2 + 1.119\,X_3 - 1.882\,X_4$	60.1	59.0	−1.83
$-\ 737.384\,X_1 + 0.884\,X_2 + 0.988\,X_3 + 0.245\,X_4$	61.2	68.5	11.90
$-\ 0.985\,Y + 4.129\,X_1 - 1.406\,X_2 + 0.900\,X_3 + 1.046\,X_4$	60.1	54.0	−10.24

Y—Seed yield, X_1— NAR (reproductive phase), X_2—CGR (reproductive phase), X_3—LAD (reproductive phase), X_4—LAI (reproductive phase), ΔG— expected genetic gain through straight selection, and $\Delta G'$—expected genetic gain through discriminant function.

Keeping in view the basic philosophy of saving time and labour in a selection programme, it would be desirable to base the selection on few characters. In this study, selection index based on two characters gave genetic gain comparable to four characters. The appreciably higher genetic gain through simultaneous selection based on LAD and LAI at reproductive phase is more desirable than the indices which involve more number of characters.

Based on the findings for physiological characters in two crosses, RH 30 × RC 781 and Prakash × RC 1425, it could be concluded that leaf area duration (LAD) and leaf area index (LAI) at reproductive phase, when used for selection simultaneously, gave the highest genetic gain. Their relative efficiency was also considerably higher than the expected gain from straight selection for yield. It was interesting to note that when the character LAD at reproductive phase was combined with any other character, the expected genetic gain improved. This means that at reproductive phase, the leaves of mustard genotypes should remain green and photosynthetically active for longer period for the transport of photosynthates towards sink. The LAD is a simple measure of integration of LAI at sequential time intervals. Nondestruction growth analysis [6, 7] may be used under field condition for measuring LAI and LAD of crop plants in a optimum plot size. The selection for high LAI prior to physiological maturity could be used with advantage for the improvement of seed yield in this crop.

ACKNOWLEDGEMENT

The first author is grateful to the Council of Scientific and Industrial Research, New Delhi, for providing financial assistance in the form of Senior Research Fellowship for conducting the present investigation.

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