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Inheritance of quantitative characters in knol khol

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ABSTRACT

Generation means analysis approach was followed to understand the inheritance of quantitative traits in knol khol (*Brassica oleracea* var. *gongylodes* L.). Two cultivars 'White Vienna' (P_1) and 'GKR' (P_2) used in the study had diverse phenotypic characteristics. Six generations *viz*., P_1, P_2, F_1, F_2, B_1, and B_2 were utilized to study the inheritance of frame size, knob size index, number of leaves per plant, days to 50% harvest, gross plant weight and knob weight. The additive dominance model was found adequate for number of leaves per plant and days to 50% harvest. It was revealed that more number of leaves per plant was dominant over lesser number of leaves per plant and genes responsible for earliness were dominant to their alleles for late maturity. For the other 4 characters digenic interaction model was found adequate thereby indicating that the expression of these characters was controlled by the interactions of two genes. The parameters [h] and [l] had opposite signs in case of all the 4 characters, which referred to as duplicate type of interaction but [l] was not significantly different from zero so the predominant type of interaction could not be classified. The positive estimates of [i] indicated that the two gene pairs for frame size, knob size index, gross plant weight and knob weight were present in associated form in the parents.

Key words: Generation means analysis, knol khol, inheritance, quantitative traits.

INTRODUCTION

Knol khol (*Brassica oleracea* var. *gongylodes* L.) is a member of cole group of vegetables belonging to the family Brassicaceae. It is one of the most under rated and under used vegetables but easiest to grow and rich in potassium and antioxidants. It is fast growing and more tolerant to heat and drought than most of the cabbage relatives. It is grown for the enlarged bulb like swelling known as knob that develops on the stem a few centimeters above the ground and is used as a vegetable before it becomes fibrous though young leaves may also be cooked. Knol khol (*kohl rabi*) has assumed importance in some of the German speaking countries of Europe. In India, it is popular in Kashmir, West Bengal and some parts of the South-India although its cultivation is not done on commercial scale. Seed production of knol khol is possible in the temperate regions experiencing a low temperature of 4^0-10^0C for 60 days (Verma and Sharma, 8) due to vernalization requirement for conversion of vegetative phase into reproductive phase. Only a few varieties of knol khol are available in India and work on varietal improvement has so far not been taken up. Before taking up a breeding programme it is important to understand the genetics of different characters for bringing desired improvement. In the present study six generations (P_1, P_2, F_1, F_2, B_1, and B_2) of a cross, involving two parents of knol khol with diverse phenotypic characters were utilized to estimate the gene effects controlling the inheritance of quantitative characters.

MATERIALS AND METHODS

Materials for the study comprised of inbreds isolated from knol khol variety 'White Vienna' and accession 'GKR' with their F_1, F_2, B_1, and B_2 generations. The former inbred has smaller sized and round knobs, smaller plant spread and leaf size, and early maturity. Where as the later has round knobs of bigger size, plant spread is more, bigger leaf size and late maturity. The two inbreds were crossed with each other and the resulting F_1 seed was sown during second season. The F_1 plants were selfed to produce F_2 seed and also backcrossed with the parents to produce B_1 and B_2 seeds. Fresh F_1 seed was also produced during the season. The harvested seeds of all the six generations *viz.,* P_1, P_2, F_1, F_2, B_1, and B_2 were sown during July and transplanted one month later in the field in a randomized block design with three replications at the Naggar Farm of the IARI, Regional Station, Katrain. In each plot measuring 3 m x 3 m, plants and rows were spaced apart at 30 cm. All the recommended cultural practices were adopted to raise a successful crop. Data were recorded on frame size (cm), knob size index (cm^2), number of leaves per plant, days to 50% harvest, gross plant weight (kg) and knob weight (kg).

Joint scaling test of Cavalli (2) was followed to estimate the mid parent [m], additive [d] and dominance [h] gene effects from the observed means

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of the six generations. This is a standard procedure (Fisher, 3; Searle, 6) where the three parameters are estimated by weighted least squares, taking as weights the reciprocals of the squared standard errors of each mean. The adequacy of additive-dominance model was determined by χ^2 -test with 3 degrees of freedom and accepted if χ^2 value was found non- significant at $p \leq 0.05$. Where this model was found inadequate, five parameters model was fitted (to provide a test for one degree of freedom) and digenic interactions terms, *viz*., additive x additive [i] and dominance x dominance [l] were included as shown by Mather and Jinks (4). The t-tests were applied on individual parameters and any non-significant term was deleted from the model to generate degrees of freedom for χ^2 tests. Ideally a satisfactory model would produce a non-significant χ^2 value whilst having each component significantly different from zero.

RESULTS AND DISCUSSION

Mean data for the two parents (P_1 and P_2) and their four generations (F_1, F_2, B_1 and B_2) are presented in Table 1. Frame size was smaller in P_1 as compared to P_2 whereas knob size index was larger in P_2 than the P_1. Gross plant weight and knob weight were also higher in P_2 than P_1. The F_1 exhibited higher mean values than the parents for all the characters except for number of leaves per plant and days to 50% harvest, which were intermediate. Rubatzky and Hang (5) have reported significant heterosis in weight and width of the enlarged stem and height and width of plant of knol khol with increased yields of 58.7-95.3% in the heterotic combinations. Verma and Sharma (7) have also reported superiority of the F_1 hybrid of knol khol over the parents with respect to earliness, shape and size of knobs, and higher yield. The means of F_2 revealed reduced vigour and decreased yield than the F_1 and the parents due to inbreeding depression which is expected in such a highly cross pollinating crop. The B_1 and B_2 generations were comparable to the parents with respect to their mean performance for all the characters.

The estimates of the three parameters and the test of goodness of fit of the additive-dominance model are presented in Table 2. The model was found inadequate for all the characters except number of leaves per plant and days to 50% harvest as revealed by their significant values. The estimates of [d] and [h] were positive and significantly different from zero for number of leaves/plant and relative values of [d] and [h] were more or less equal. Therefore, dominance was present for the character and that the genes producing more number of leaves were in general dominant to their alleles which produced lesser number of leaves. For days to 50% harvest, the estimates of [d] and [h] were negative and significantly different from zero concluding that dominance was present for the genes responsible for early maturity over the genes resulting in lateness.

The estimates of five parameters along with interactions followed by progressive elimination of non-significant components are presented in Table 3. The digenic interaction model was found adequate for all the four traits as the χ^2 values were found non-significant for each trait. Except the [l] component the remaining four parameters were significant for all the 4 traits. The parameters [h] and [l] had opposite signs in case of all the four characters, which referred to as duplicate type of interaction. But [l] was not significantly different from zero and hence the predominant type of interaction could not be classified. Positive estimates of [i] suggest that the sum of the interactions from the dispersed pairs of genes is less than half the sum of all interactions (Mather and Jinks, 4). Conversely when the contribution from dispersed pairs is more than half, [i] will have the negative sign (Mather and

Table 1. Mean data and standard errors of six generations for different characters in a cross 'White Vienna' X 'GKR' of knol khol.

Character	P_1	P_2	F_1	F_2	B_1	B_2
Frame size (cm)	50.67 ± 0.57	70.30 ± 1.19	82.93 ± 14.38	51.93 ± 0.07	59.93 ± 3.08	73.13 ± 4.10
Knob size index (cm^2)	108.77 ± 0.72	114.43 ± 2.20	160.13 ± 35.12	54.70 ± 1.27	126.73 ± 17.94	114.97 ± 10.85
No. of leaves	20.23 ± 0.65	19.17 ± 0.44	19.67 ± 1.75	20.50 ± 0.29	20.80 ± 1.36	19.33 ± 0.47
Gross plant wt. (kg)	0.75 ± 0.03	1.05 ± 0.01	1.48 ± 0.47	0.41 ± 0.05	1.03 ± 0.23	1.17 ± 0.15
Knob wt. (kg)	0.61 ± 0.01	0.67 ± 0.01	1.07 ± 0.32	0.22 ± 0.01	0.72 ± 0.16	0.63 ± 0.06
Days to 50% harvest	117.67 ± 4.67	147.00 ± 10.00	122.33 ± 4.67	142.33 ± 14.6	132.33 ± 12.98	142.33 ± 14.67

Table 2. Estimates of three parameters for six quantitative characters.

Character	[m]	[d]	[h]	χ^2 (at 3 d.f.)
Frame size	60.34* ± 0.65	-9.68* ± 0.65	-16.80* ± 1.32	43.83*
Knob size index	111.56* ± 1.15	-2.86* ± 1.15	-110.61* ± 3.41	2682.3*
No. of leaves	19.82* ± 0.38	0.74* ± 0.36	0.85* ± 0.35	0.07
Gross plant wt.	0.89* ± 0.01	-0.15* ± 0.01	-0.74* ± 0.09	16.86*
Knob wt.	0.63* ± 0.01	-0.03* ± 0.01	-0.77* ± 0.02	9.55*
Days to 50% harvest	134.25* ± 5.19	-15.54* ± 5.23	-10.26* ± 5.15	3.31

* Significant at $p \leq 0.05$

Table 3. Estimates of five parameters for four quantitative characters.

Parameter	Frame size	Knob size index	Gross plant wt.	Knob wt.
[m]	4.04* ± 1.86	-139.56* ± 37.55	-1.84* ± 0.53	-0.98* ± 0.23
[d]	-9.87* ± 0.65	-2.78* ± 1.15	-0.15* ± 0.01	-0.03* ± 0.004
[h]	112.77* ± 32.39	477.37* ± 117.45	5.70* ± 1.60	2.77* ± 0.77
[i]	56.50* ± 9.85	251.13* ± 37.50	2.75* ± 0.53	1.62* ± 0.23
[l]	-33.72 ± 34.86	-177.68 ± 102.45	-2.37 ± 1.37	-0.73 ± 0.78
χ^2 (at 1 d.f.)	0.09	1.0	0.02	0.02

* Significant at $p \leq 0.05$

Jinks, 4). The increasing alleles of the two gene pairs for frame size, knob size index, gross plant weight and knob weight seem to be associated in one parent and the decreasing alleles in the other parent, as the [i] estimates for these traits were positive. The two parents used in the study had phenotypically contrasting characters therefore; we expect that the genes might be associated as revealed by the [i] estimates.

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