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B.S. Chandel
Biopesticides and Toxicological Lab., Department of Zoology, D. B. S. College, Kanpur (India).

D.S. Bhadauria
Biopesticides and Toxicological Lab., Department of Zoology, D. B. S. College, Kanpur (India).

Correspondence:
B.S. Chandel
Biopesticides and Toxicological Lab., Department of Zoology, D. B. S. College, Kanpur (India).

Assessment of resistance to the attack of pulse beetle, *Callosobruchus chinensis* (Fabricius) in chickpea genotypes on the basis of various physical parameters during storage

B.S. Chandel, D.S. Bhadauria

Abstract
Experiments were conducted in the laboratory, Department of Zoology, D.B.S. College, Kanpur to find out the impact of physical characteristics of promising varieties of pigeonpea, *Cajanus cajan* Linn. on infestation of pulse beetle. The promising genotypes viz; PUSA–84, PRABHAT, MANAK, AMAR, PUSA-33, ICPL-151, UPAS-120, JAGARTI, TYPE-7, PUSA-9, BAHAR, and TYPE-21 of pigeonpea were obtained from IIPR, Kalyanpur, Kanpur. The results indicated that mean test weight was found to be 94.35 g and most of varieties were not deviating from the mean except PRABHAT and UPAS-120. The seeds of PUSA-33(11.9), PUSA-9 (13.9), TYPE-7 and BAHAR (13.1) Kg/ grain, had significantly more hardness. The average moisture content in pigeonpea varieties was found to be 12.39 per cent. The mean protein content was 22.99 per cent in pigeonpea varieties. AMAR possessed the lowest protein content (21.80 per cent) and had significantly poor protein content. It can be concluded that TYPE -7 variety of pigeonpea showing the least weight loss (15.82%) due contained 110.13g test weight, 13.1 kg hardness/grain, 12.5 per cent moisture and 21.80 per cent protein. It is followed by IPCL-151(17.03%) due to 98.423g test weight, 7.6 kg hardness/grain, 12.3per cent moisture and 22.40 per cent protein.

Keywords: Pigeonpea, *Cajanus cajan* Linn. genotypes, BAHAR, PUSA-9 and Amar, ICPL-151and PUSA–84.

1. Introduction
Most of the pulses have to be stored by the traders and Government agencies in Gowdown for more than one years for future use. (Swaminathan 1977 [1]. Anonymous 1991[2]. Verma *et al*.1999) [3]. In India, the pulses are stored by the farmers using country method (Ahmed *et al.* 1989) [4]. Most of the pulse beetle infests the pods and grains from the field and hidden infestation is not detected before storing of the pulses. So, the heavy amount of stored produce is lost by the beetles. Therefore it is essential to know the factors responsible for causing this damage (Arora and Singh 1970 [5]. Shehnaz and Theophillus 1975) [6]. That is why the present study was under taken to see the effect of physical parameter of the grain to affect the damage.

2. Materials and Methods
The various physical characters viz; test weight, sample size, Hardness of grains, moisture content and protein contents of this genotype were recorded to find out their relationship with the pest multiplication during the year 2004-2006.

2.1. Test Insect
A large number of adults of pulse beetle, *C. chinensis* were collected from the local Godowns. It was identified by the experts in the Department of Entomology, C.S. Azad University of agriculture and technology, Kanpur showing the main characters as there length about 4 mm and elevated ivory like spots near the middle of the body. The male beetle is smaller than the female in the body size. The tip of abdomen of male is blunt, while in case of female, it is pointed and the pygidium is more exposed. The antennae of male pectinate, while in case of female it is serrate. The elytra of male beetle is spotted with white dots and light in colour, whereas in female it is dark coloured and without white dots. We have maintained the culture by selecting one pair of the test insect.

2.2. Maintenance of culture

The mass breeding of selected individuals was carried out on pigeonpea variety T-21 in glass jar of three kg capacity with their mouth tied with muslin cloth and rubber band under control temperature of 27±2^{0}c and 75±5 per cent relative humidity in the departmental research laboratory. The culture jars were replaced at each generation to multiply the culture, so as to get desired number of individuals for all the experiments (Brewer and Horber 1983) [7]. For obtaining the fresh adult of *C. chinensis* of known age, large number of pigeon pea seeds, laid with eggs was placed in fresh jars. The jars were examined daily for the emergence of adults on a particular date and were collected for the experimental purpose.

2.3. Study of Physical Parameter

The details of methods of assessment of test weight, hardness of grain, determination the moisture contents like physical characters on adult of *C. chinensis* are as under:-

2.3 a. Test Weight

The test weight of 1000 grains of different pigeonpea varieties was taken by numerical counting and weighing of sound grains. The grains in 25 g sample of each variety were counted replication wise and their average was taken to correlate them with biological aspects of test insect.

2.3 b. Hardness of Grain

The hardness of grain of each variety was determined on the basis of their breaking strength with the help of O.S.K. 201 Grain Hardness Tester Type "E" (capacity 50 kg) in the Department of chemistry of the college.

2.3 c. Moisture Contents

To determine the moisture contents, fresh grains of each variety were properly sterilized in an oven at 25^{0}c for four hours and placed in desiccators at 75±5 per cent relative humidity maintained with potassium hydroxide for 15 days to keep the constant level of moisture (Singh *et al.*1980) [8]. Later on moisture content was determined with the help of O.S.A.W. universal moisture meter in the Departmental laboratory. (Mishra, 1968) [9].

2.3 d. Protein contents

Protein contents were determined in the Department of Chemistry by the biuret method (Newman 1964 [10], Snedecor and Cochran 1968 [11]).

2.4 e Statistical Analysis Carried

To obtain more accurate information, the adults emerged out till another fifteen days in the fourth replication only were taken into account and the developmental period was calculated on the basis of weight mean by using following formula:

Weighed mean = WX / W

Where, X= value of an observation in days.

W= weight of x (emergence of adult)

To find out the total losses caused by the pulse beetle, the weight of the fresh sample (n_2) and that of damaged grain (n_1), were taken into account and losses were calculated using by the following formula: Total loss (%) = $n_2 – n_1 / n_2$ X 100

3. Results

The varieties were tested for their test weight, hardness, moisture and protein content for determining their effect on the biology of *C. chinensis.*

3.1. Test Weight

The mean test weight was found to be 94.34 g (Table- 1) and most of varieties were not deviating from the mean except PRABHAT and UPAS-120, which were having significantly less test weight, being 70.52 and 84.46 g, while BAHAR and JAGARTI had significantly high test weight of 118.90 g each, respectively. As the sample weighing 25 g were taken for carrying out the investigations on the biological aspects of the pest, the number of grains in each sample were also counted.

3.2. Number of the Grains in each Sample

The mean number of the grains in each sample was 278.71, but the number of grains was significantly higher than the mean in case of UPAS-120 (335.75) and PRABHAT (285.50) number of grain per sample, while BAHAR, PUSA-9 and TYPE-7 showed less, number of grains per sample being 210.20, 226.50 and 227.00, respectively. The increase in the number of grains per sample may be attributed to less test weight and *vice-versa*.

3.3. Hardness in Seeds

The perusal of Table-1 also indicated a varying degree of hardness in seeds of different variety of pigeonpea with the mean value of 8.89 kg per grain. The seeds of TYPE-7, BAHAR, PUSA-33 and PUSA-9 had significantly more hardness i.e. 13.1, 131, 11.9 and 11.3, respectively, meanwhile, JAGARTI had minimum hardness of 5.5 kg per grain.

Table 1: Physical characteristics of different *C. cajan* varieties on resistance to the attack of pulse beetle

Variety	Physical Characters		
Character	**Test Weight Grain (g)**	**Number of Grains/ Sample (N G/S)**	**Hardness Kg/ grain X_3**
Amar - (V_1)	70.52	354.50	8.5
Bahar - (V_2)	118.90	210.20	13.1
IPCL-151 - (V_3)	98.42	255.25	7.6
Jagrati - (V_4)	118.90	263.25	5.5
Manak - (V_5)	79.76	278.50	7.0
Prabhat - (V_6)	70.52	385.50	12.3
Pusa-9 - (V_7)	110.37	226.50	13.9
Pusa-33 - (V_8)	89.92	278.00	11.9
Pusa-84 - (V_9)	78.92	316.75	8.3
Type-7 - (V_{10})	110.13	227.00	13.1
Type-21 - (V_{11})	84.20	314.00	6.4
Upas-120 - (V_{12})	74.46	335.75	6.7
Mean	94.34	278.71	8.90
S.C.	16.83	45.37	2.71
S.E. ±	4.86	13.09	0.78

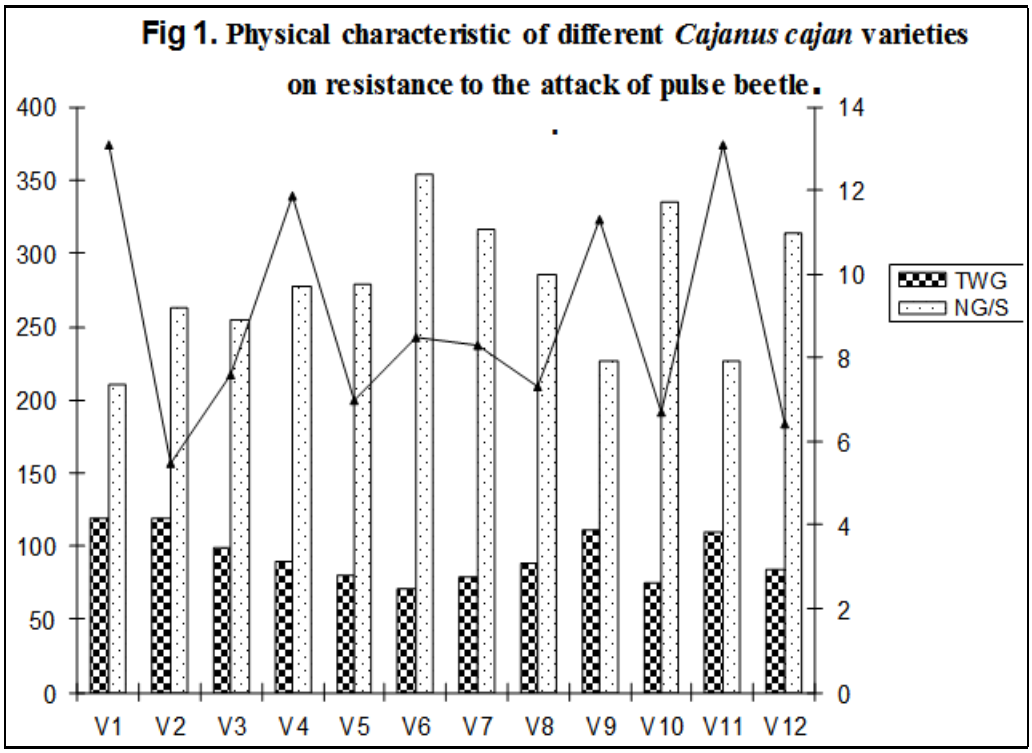

Fig 1. Physical characteristic of different *Cajanus cajan* varieties on resistance to the attack of pulse beetle.

3.4. Moisture Content

The average moisture content in pigeonpea varieties was found to be 12.39 per cent with a very little variation from variety to variety (Table- 1).Variety PRABHAT was recorded significantly high (13.0 per cent), and PUSA-9 low moisture content (12.3 per cent) only. This slight variation in the moisture content may be associated with the varietal characteristics.

3.5. Protein Content

The mean protein content was 22.99 per cent in pigeonpea varieties with a slight variation from variety to variety (Table – 1). AMAR possessed the lowest protein content (21.80 per cent) and had significantly poor protein content, while it was significantly higher in PRABHAT (19.90 per cent), TYPE-21 (26.06 per cent) and PUSA-9 (27.00 per cent). The protein in pigeonpea varieties is a bio-genetic characteristic varying from variety to variety.

3.6. Actual Losses

The amount of the actual losses caused by the grubs of *C. chinensis* in their life span was assessed on the basis of actual loss in weight in the whole sample by reducing the weight of infested as well uninfected grains together. The actual losses were found to be on an average 10.12 per cent with its maximum 09.45 on variety UPAS-120 closely followed by 11.92 in MANAK and 11.81 in TYPE-21 minimum 7.41 per cent in TYPE-7 without significant different from ICPL-151 (8.95 per cent), PUSA-33 (8.94 per cent), PUSA-9 and AMAR (9.45 per cent), JAGARTI (9.86 per cent) and PDA 3 (9.76 per cent).

The above interpretation of the results indicate that pulse beetle *C. chinensis* caused 49.47 per cent infestation of seeds of Pigeon pea irrespective of varieties and its total losses were to the extent of 49.57 per cent. The actual losses calculated on the basis of actual reduction in the seed weight, were found to be 10.12 per cent. The different varieties showed their varying response to pulse beetle infestation; it was maximum 67.92 per cent in BAHAR, followed by 60.91 per cent in TYPE-21 against its minimum of 39.73 in PRABHAT. The infestation in other varieties was ranging between 41.83 to 52.44 per cent. The total loss in weight was also maximum (68.08 per cent) in case of BAHAR followed by 59.03 per cent in case of TYPE-21 with a minimum loss of 40.12 per cent in PRABHAT. The other varieties were having 42.52 – 53.66 per cent losses. The data on the actual losses caused by the pest showed slightly different trend, as the variety, UPAS-120, MANAK and TYPE-21 were suffered upto the extent of 13.08, 11.92 and 11.81 per cent, while the actual losses in BAHAR and PUSA-84 were only 10.39 per cent against a minimum level of TYPE-21.

The infestation and losses were found to be positively associated with the test weight and moisture content, while the number of grains per sample responded negatively upto a remarkable extent. There was no role of protein content of seeds neither on losses nor on infestation of the pest. The losses were also found to be dependent upon emergence of the adults, but total numbers of eggs laid in each sample were not found to affect the losses.

4. Discussion

A study on the relative resistance of pigeonpea varieties to bruchid (*C. chinensis*) was undertaken and significant differences between varieties were observed with regard to their relative physical characters. The variation in seed physical parameters was primarily due to variation in percent infestation level, reduction in seed weight and also inherent capacity of each variety to be attacked by *C. chinensis*.

From the above results it may be concluded that least weight loss was obtained in the pigeonpea varieties Type-7 heaving test weight loss 110.13g test weight, 13.1 kg hardness/grain, 12.5 per cent moisture and 21.80 per cent protein. It is followed by IPCL-151(17.03%) due to 98.423g test weight, 7.6 kg hardness/grain, 12.3per cent moisture and 22.40 per cent protein. Maximum test weight loss 21.25g is recorded in genotype AMAR, hardness 8.5Kg/grain, 12.4 per cent

moisture and 21.80per cent protein. Similar findings were obtained by Shaheen *et al.*(2006) [12], who showed that cultivars with hard, rough, wrinkled and thick seed coat proved to be more resistant when compared with those having smooth, soft and thin seed coat. Lambrides and Imrie (2000) [13]. reported that the tolerant varieties showed the least loss in weight of seeds due to bruchid, which could be attributed to the small size and the presence of well-formed texture layer on the seed and it was supported by Applebaum and Birk 1972 [14], Mills 1976 [15], Daniel *et al.*1977 [16], Ahmad *et al.*1993 [17], Amevoin *et al.*2005 [18]. The resistance to *Callosobruchus chinensis* in legume may be related to tegument components as pigments in dark tegument genotypes. The resistance to bruchids in legume may be related to tegument components as pigments in dark tegument genotypes, and to the presence of linoleic acid, affecting oviposition and also larval feeding or larval biology (McCarthy and Parlle 1977 [19], Vimla and Pushpamma 1983 [20], Athiepacheco *et al*., 1994 [21]. Bhatnagar *et al.* 2001 [22])

5. Conclusion

From the above results it may be concluded that least weight loss was obtained in the pigeonpea varieties Type-7 variety of pigeonpea showing the least weight loss (15.82%) due contained 110.13g test weight, 13.1 kg hardness/grain, 12.5 per cent moisture and 21.80 per cent protein. It is followed by IPCL-151(17.03%) due to 98.423g test weight, 7.6 kg hardness/grain, 12.3per cent moisture and 22.40 per cent protein. On the other hand maximum test weight loss 21.25g is recorded in genotype AMAR, hardness 8.5Kg/grain, 12.4 per cent moisture and 21.80per cent protein effect to the attack of pulse beetle, *Callosobruchus chinensis* Linn.

Table 2: Mean moisture content and protein content of different *Cajanus cajan* varieties on resistance to the attack of pulse beetle.

Variety	Physio-chemical Character		
	Test Weight Grain g	Moisture % (X_1)	Protein % (X_2)
Amar (V_1)	70.52	12.4	21.80
Bahar (V_2)	118.90	12.6	21.20
IPCL-151(V_3)	98.42	12.3	22.40
Jagrati (V_4)	118.90	12.5	22.40
Manak (V_5)	79.76	12.4	23.01
Prabhat (V_6)	78.92	12.3	23.10
Pusa-9 (V_7)	110.37	13.0	27.00
Pusa-33 (V_8)	89.92	12.3	21.80
Pusa-84 (V_9)	87.64	12.3	19.99
Type-7 (V_{10})	110.13	12.5	21.80
Type-21 (V_{11})	84.20	12.6	26.06
Upas-120 (V_{12})	74.46	11.3	25.42
Mean	94.34	2.40	22.99
S.C.	16.83	0.35	21.10
S.E. ±	4.86	0.10	0.60

TWG: Test weight grain, M % X_1: Moisture % X_1, P % X_2: Protein % X_2

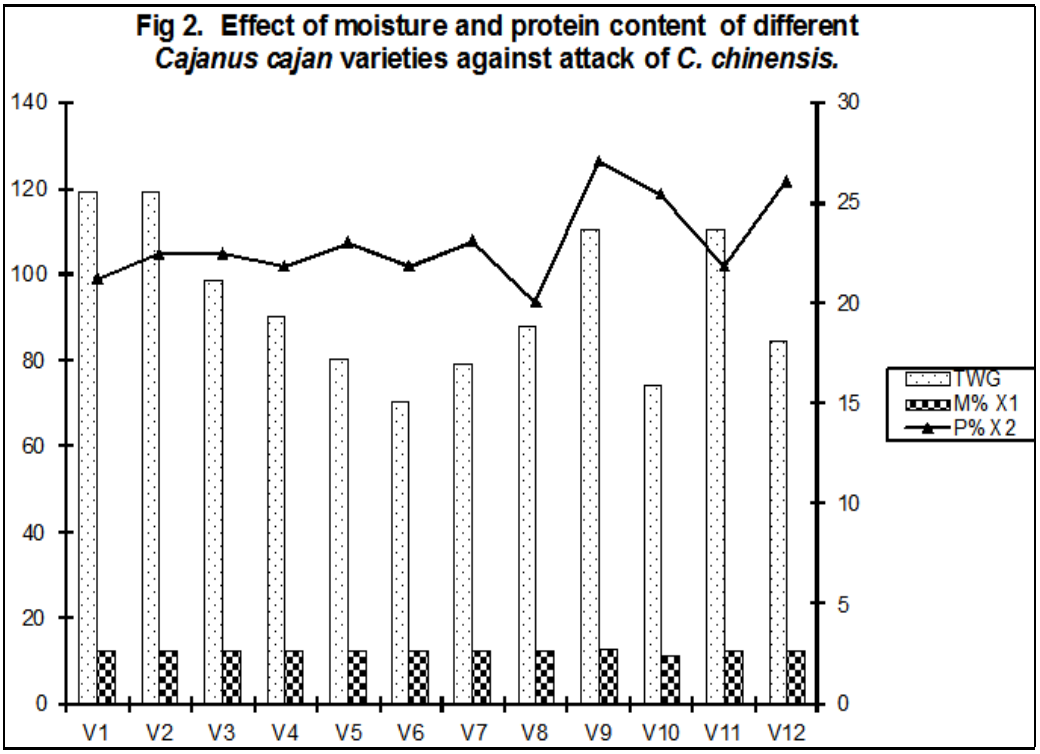

Table 3: Extent of losses of *C. cajan due to C. chinensis.*

Variety	% infestation		Weight Loss (%)		Actual Weight Loss (%)		Consumption
Pigeonpea	Angular Values	TBV	Angular Values	TBV	Angular Values	TBV	of food per grub (mg)
AMAR -V_1	40.32	41.83	41.28	43.56	21.25	13.08	22.14
BAHAR -V_2	55.55	67.92	55.59	68.08	18.83	10.39	18.20
IPCL-151 -V_3	42.67	45.99	42.67	45.99	17.03	08.95	18.24
JAGRATI -V_4	43.43	47.21	44.00	48.26	18.28	09.86	20.05
MANAK -V_5	45.33	50.52	46.09	51.92	20.20	11.92	20.71
PRABHAT -V_6	39.10	39.73	39.31	40.12	18.23	09.76	18.09
PUSA-9 -V_7	46.36	52.44	47.12	53.66	17.91	09.45	20.18
PUSA-33 -V_8	40.67	42.52	40.67	42.52	17.39	08.94	18.82
PUSA-84 -V_9	41.28	43.57	41.28	43.56	18.80	10.39	18.63
TYPE-7 -V_{10}	45.88	51.57	44.92	49.83	15.82	07.41	16.09
T YPE-21 -V_{11}	51.30	60.91	50.18	59.03	20.11	11.81	15.36
UPAS-120 -V_{12}	44.75	39.48	43.99	48.26	17.92	09.45	16.87
Mean	0.780	49.47	0.594	49.57	1.324	12	18.62
SE $\pm$	1.610		1.226		2.733		1.113
CD at 5 %							2.297

Table 4: Effect of Physico-chemical characteristic of *C. cajan* on infestation of *C. chinensis.*

4.1. Correlation coefficient

Sl. No.	Seed Character (X)	Particular of Seed Character	Correlation Coefficient (r)
1.	X_1	Test weight	0.55@
2.	X_2	Grains/Sample	-0.52*
3.	X_3	Hardness	0.34
4.	X_4	Moisture	0.55@
5.	X_5	Protein	0.04

@ =Significant at 10.00% level

* = Significant at5.00 % level

4.2. Individual regressors

Sl. No.	Regression Equation	Seed Character
1.	Y= 24.03 + 0.27	X_1
2.	Y= 78.43 + 0.10	X_2
3.	Y= 40.46 + 1.01	X_3
4.	Y=-107.86 + 12.70	X_4
5.	Y= 45.65 + 0.17	X_5

4.3 Multiple regressors of seed character with percentage grain having eggs.

Sr.	Regression Equation	Coefficient of Regression (R^2)
1.	$Y= 78.4256 – 0.1039\ X_2$	0.3305
2.	$Y= -29.7209 – 0.0718\ X_2 + 8.0053\ X_4$	0.4193
3.	$Y = -34.1534 – 0.0748\ X_2 + 7.7746\ X_4 + 0.3540\ X_5$	0.4274
4.	$Y = -32.7916 – 0.0779\ X_2 – 0.0908\ X_3 + 7.8224\ X_4 + 0.3409\ X_5$	0.428
5.	$Y = - 35.6915 + 0.0170\ X_1 – 0.0714\ X_2 – 0.0672\ X_3 + 7.7618\ X_4 + 0.3433\ X_5$	0.4281

Table 5: Effect of physico-chemical characteristics of pigeonpea on on percent weight loss.

5.1 Correlation coefficient

S. No.	Seed Character Total No of egg/ female	Correlation coefficient (r)	Biological parameter of *C. chinensis*	Correlation coefficient (r)
1.	Test weight (X_1)	0.57*	Weight loss x food consumption	-0.22
2.	Grains/Sample (X_2)	- 0.58*	Total no. of eggs x weight loss	-0.36
3.	Hardness (X_3)	0.33	Emergence x weight loss	0.79*
4.	Moisture (X_4)	0.57*	Developmental period x weight loss	-0.17
5.	Protein (X_5)	0.06		

* = Significant at 5.00 percent level

5.2. Individual regressors

Sl. No.	Regression Equation	Seed Character
1.	Y= 24.32 + 0.27	X_1
2.	Y= 77.57 – 0.10	X_2
3.	Y= 41.08 + 0.95	X_3
4.	Y= - 107.22 + 12.65	X_4
5.	Y=44.38 + 0.23	X_5

5.3 Multiple regressors of seed character with percentage grain having eggs.

Sl. No.	Regression Equation	Coefficient of Regression (R^2)
1.	$Y= 77.57 – 0.10 X_5$	0.335
2.	$Y= -33.85 + 8.25 X_4 – 0.07 X_2$	0.437
3.	$Y = -38.88 – 0.07 X_2 + 7.20 X_4 + 0.40 X_5$	0.448
4.	$Y = - 49.10 + 0.07 X_1 – 0.05 X_2 +7.79 X_4 + 0.40 X_5$	0.451
5.	$Y = -47.59 + 0.06 X_1 – 0.05 X_2 – 0.04 X_3 + 7.83 X_4 + 0.39 X_5$	0.451

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