J. Sher-e-Bangla Agric. Univ., 3(2): 24-29, July 2009 ISSN 1997-6038

CORRELATION AND PATH COEFFICIENT ANALYSIS IN LENTIL (*Lens culinaris* MEDIC.)

A. C. Deb[1], A. K. Dutta[2] and M. A. Khaleque[3]

ABSTRACT

The study on correlation and path coefficient was conducted to determine the contribution of different traits to seed yield in lentil (*Lens culinaris* Medic.). Six M_3 lines of lentil were evaluated in a replicated field trial for twelve yield and yield contributing characters *viz*. days to first flower (DFF), plant height at first flower (PHFF), number of primary branches at first flower (NPBFF), number of secondary branches at first flower (NSBFF), number of secondary branches at maximum flower (NSBMF), plant area per plant (PAPP), plant weight per plant (PWPP), root weight per plant (RWPP), number of pods per plant (NPdPP), pod weight per plant (PdWPP), number of seeds per plant (NSPP) and seed weight per plant (SWPP). In correlation analysis, SWPP was positively correlated with all the characters but significantly correlated with DFF, NPdPP, PdWPP and NSPP at genotypic level. But at phenotypic level, SWPP significantly correlated only with NPdPP. Path coefficient analysis revealed that NPdPP and NSPP had the highest direct effect on SWPP both at phenotypic and genotypic levels. The second highest direct effect on SWPP was noted for PdWPP at phenotypic level and NPdPP at genotypic level. The results of correlation and path coefficient analysis both at phenotypic and genotypic levels showed that NPdPP and NSPP were the most important yield components because they showed significant correlation with SWPP at genotypic level and highest direct positive effect on SWPP both at phenotypic and genotypic levels.

Key words: Correlation coefficient, path coefficient, yield and yield component

INTRODUCTION

Lentil (*Lens culinaris* Medic.) is a nutritious food legume. In Bangladesh, lentil is the most popular and important pulse crop in terms of both area and production (BBS, 2008). It is primarily a rain fed rabi crop. Yield stability is a major objective in any breeding program. This could be achieved through a better understanding of the components contributing to final yield. Correlation and path coefficient analyses have been successfully used for plant selection for increasing yields of different crops. Seed yield in lentil is a complex character and is the product of several contributing factors affecting yield directly or indirectly. Estimation of simple correlation between various agronomic characters may provide good information necessary for breeders, when selection is based on two or more traits simultaneously. Information obtained from correlation coefficients for these characters could also be useful as indicators of the more important ones under consideration. The association among traits may be measured by genotypic and/or phenotypic coefficients of correlation depending on the types of materials and the kind of experimental design used. Path coefficient is an excellent means of studying direct and indirect effects of interrelated components of a complex trait (Kang *et al.* 1989). Each correlation coefficient between a predictor variable and the response variable is partitioned into its component parts: the direct effect or path coefficient for the predictor variable and indirect effects, which involve the product of a correlation coefficient between two predictor variables with the appropriate path coefficient in the path diagram (Dewey and Lu 1959). This technique, therefore, provides a critical examination of specific factors producing a given correlation and can be successfully employed in formulating a selection strategy. Plant breeders generally select for only a few traits and it is very important to know the effects of these traits on other important characters as well. So, the present study was taken under to investigate the interrelationship of yield components and the type and extent of their contribution to yield.

[1]Dr. Anil Chandra Deb, Associate Professor, Department of Genetic Engineering and Biotechnology, University of Rajshahi, [2]A. K. Dutta, Lecturer, Department of Genetic Engineering and Biotechnology, University of Rajshahi, Rajshahi 6205, Bangladesh. [3]Dr. M.A. Khaleque, Professor, Department of Botany, University of Rajshahi, Rajshahi 6205, Bangladesh.

MATERIALS AND METHODS

Twelve yield and yield contributing characters of six M_3 lentil lines *viz.* Barimasur-1 (Bm 1), Barimasur-2 (Bm 2), Barimasur-3 (Bm 3), Barimasur-4 (Bm 4), ILL 7543 (L6) and ILL 8010 (L11) were grown in a randomized complete block design with three replications. Above lines were irradiated with different doses Krad gamma-rays (Kr) *i.e.*, 20kr, 25kr and 30kr. Irradiation was done with Co^{60} source in the Institute of Food and Radiation Biology, Atomic Energy Research Establishment, Savar, Dhaka. For the study of correlation coefficient and path coefficient, the analysis of both variance and covariance are required (Miller *et al.*, 1958). Therefore, covariances were calculated between all the possible pairs of characters. Path coefficient analysis has been done according to the method of Dewey and Lu (1959) by solving the simultaneous equation using phenotypic and genotypic correlation.

RESULTS AND DISCUSSION

Correlation studies have been done both at phenotypic and genotypic levels and showed that genotypic correlation was higher than the respective phenotypic correlation in most of the cases (Table 1).

Table 1. Phenotypic (r_p) and genotypic (r_g) correlation coefficients between yield and yield contributing character in lentil.

Characters	PHFF	NPBFF	NSBFF	NSBMF	PAPP	PWPP	RWPP	NPdPP	PdWPP	NSPP	SWPP	
DFF	0.3768	0.1096	0.3526	0.3206	0.1501	0.2158	0.1870	0.2897	0.3131	0.2982	0.1103	P
	0.8161	0.8775*	1.0779**	1.3158*	1.1868*	1.3240*	0.8993*	1.1409*	0.9006*	1.2671*	0.9395**	G
PHFF		0.7164	0.7606	0.3802	0.4680	0.5171	0.5527	0.3667	0.2707	0.3504	0.3545	P
		1.1174*	0.9316**	0.6455	1.0159**	0.9624**	0.9871**	0.4443	0.3460	0.5831	0.3945	G
NPBFF			0.7272	0.2543	0.3319	0.5543	0.4369	0.4223	0.3573	0.3310	0.4139	P
			0.9910**	0.6411	1.2062*	0.9265**	1.1279*	0.4064	0.3853	0.5562	0.4778	G
NSBFF				0.5922	0.5456	0.6836	0.6097	0.6527	0.5024	0.5614	0.5764	P
				0.9556**	1.1252*	1.0680**	0.8971*	0.8155*	0.7516	0.9282**	0.7168	G
NSBMF					0.4721	0.6625	0.5368	0.6788	0.5026	0.6753	0.5653	P
					0.9427**	0.9926**	0.4976	1.0930**	1.0069**	1.1438*	0.7673	G
PAPP						0.7399	0.6175	0.5607	0.4411	0.6541	0.5802	P
						1.0584**	1.0232**	0.8484*	0.8079	0.8830*	0.8786	G
PWPP							0.7265	0.7033	0.5370	0.7114	0.6477	P
							0.9011*	0.8447*	0.7271	0.9580**	0.7375	G
RWPP								0.5111	0.3421	0.5072	0.5290	P
								0.4364	0.3973	0.5597	0.6411	G
NPdPP									0.7694	0.8615*	0.8459*	P
									1.0282**	1.0359*	0.8542*	G
PdWPP										0.6532	0.7554	P
										0.9726*	0.9232**	G
NSPP											0.7320	P
											0.8628*	G

* and ** indicates significance at 5% and 1% level, respectively. P=Phenotypic, G=Genotypic

DFF = Days to first flower, PHFF = Plant height at first flower, NPBFF = Number of primary branches at first flower, NSBFF = Number of secondary branch at first flower, NSBMF = Number of secondary branches at maximum flower, PAPP = Plant area per plant, PWPP = Plant weight per plant, RWPP = Root weight per plant, NPdPP = Number of Pods per plant, PdWPP =Pods weight per plant, NSPP = Number of seeds per plant, SWPP = Seed weight per plant

This situation was also marked in the path-coefficient analysis. The high genotypic correlation indicating the strong inherent associations between pairs of characters do not always reflect the nature and magnitude of phenotypic variation. Higher magnitude of genotypic correlation than phenotypic one were also found by Nahar and Khaleque (1996) in sugarcane, Husain *et al.* (1997) in chili, Deb (2003) in chickpea, Hasan *et al.* (2003) in mashbena and Sarker and Deb (2006) in blackgram.

In the present investigation, SWPP showed positive correlation with all the characters both at phenotypic and genotypic levels. But SWPP showed significant positive correlation with DFF, NPdPP, PdWPP and NSPP at genotypic level and at phenotypic level SWPP showed significant positive correlation only with NPdPP indicating that these characters were genetically related with SWPP more than those of the other yield components. The significant correlation of SWPP with DFF, NPdPP, PdWPP and NSPP indicated the effectiveness for directional selection for genetic improvement of lentil yield and suggested that with the increase of these characters yield (SWPP) will be increased. Significant and positive correlation were also obtained by Singh and Malhotra (1970) in mungbean, Ghafoor *et al.* (1990) and Hassan *et al.* (2003) in mashbean, Yaqoob *et al.* (1997) in mungbean, Deb (2003) in chickpea, Khaliq *et al.* (2004) in bread wheat and Saleem *et al.* (2007) in maize.

The picture became clear when correlation coefficients were partitioned into direct and indirect effects by path analysis both at phonotypic and genotypic levels. The results of path analysis are presented in Table 2 and 3 and shown in Figure 1.

Table 2. Path coefficient analysis showing direct and indirect effects of yield components on yield of lentil at phenotypic level

Characters	SWPP$_{VS}$											Path coefficient
	DFF	**PHFF**	**NPBFF**	**NSBFF**	**NSBMF**	**PAPP**	**PWPP**	**RWPP**	**NPdPP**	**PdWPP**	**NSPP**	
DFF	**-0.1965**	-0.0741	-0.0215	-0.0693	-0.0630	-0.0295	-0.0424	-0.0367	-0.0569	-0.0615	-0.0586	-0.1965
PHFF	0.0293	**0.0779**	0.0558	0.0592	0.0296	0.0364	0.0403	0.0430	0.0286	0.0211	0.0273	0.0779
NPBFF	-0.0204	-0.1336	**-0.1865**	-0.1356	-0.0474	-0.0619	-0.1034	-0.0815	-0.0788	-0.0666	-0.0617	-0.1865
NSBFF	-0.0116	-0.0250	-0.0239	**-0.0329**	-0.0195	-0.0179	-0.0225	-0.0200	-0.0214	-0.0165	-0.0184	-0.0329
NSBMF	0.0041	0.0049	0.0033	0.0076	**0.0129**	0.0061	0.0085	0.0069	0.0088	0.0065	0.0087	0.0129
PAPP	0.0157	0.049	0.0347	0.0571	0.0494	**0.1046**	0.0774	0.0646	0.0587	0.0462	0.0684	0.1046
PWPP	-0.0110	-0.0264	-0.0283	-0.0349	-0.0339	-0.0378	**-0.0511**	-0.0371	-0.0359	-0.0274	-0.0364	-0.0511
RWPP	0.0243	0.0719	0.0569	0.0794	0.0699	0.0804	0.0946	**0.1302**	0.0665	0.0445	0.0660	0.1302
NPdPP	0.1751	0.2217	0.2553	0.3946	0.4103	0.3389	0.4251	0.3089	**0.6045**	0.4651	0.5208	0.6045
PdWPP	0.1065	0.0921	0.1215	0.1709	0.1709	0.1500	0.1826	0.1164	0.2617	**0.3401**	0.2222	0.3401
NSPP	-0.0447	-0.0526	-0.0497	-0.0842	-0.1013	-0.0981	-0.1067	-0.0761	-0.1292	-0.0980	**-0.1500**	-0.1500
Total effect	0.1103	0.3545	0.4139	0.5764	0.5653	0.5802	0.6477	0.529	0.8459	0.732	0.7554	

Residual effect = 0.5727 and **Bold** indicates direct effect.

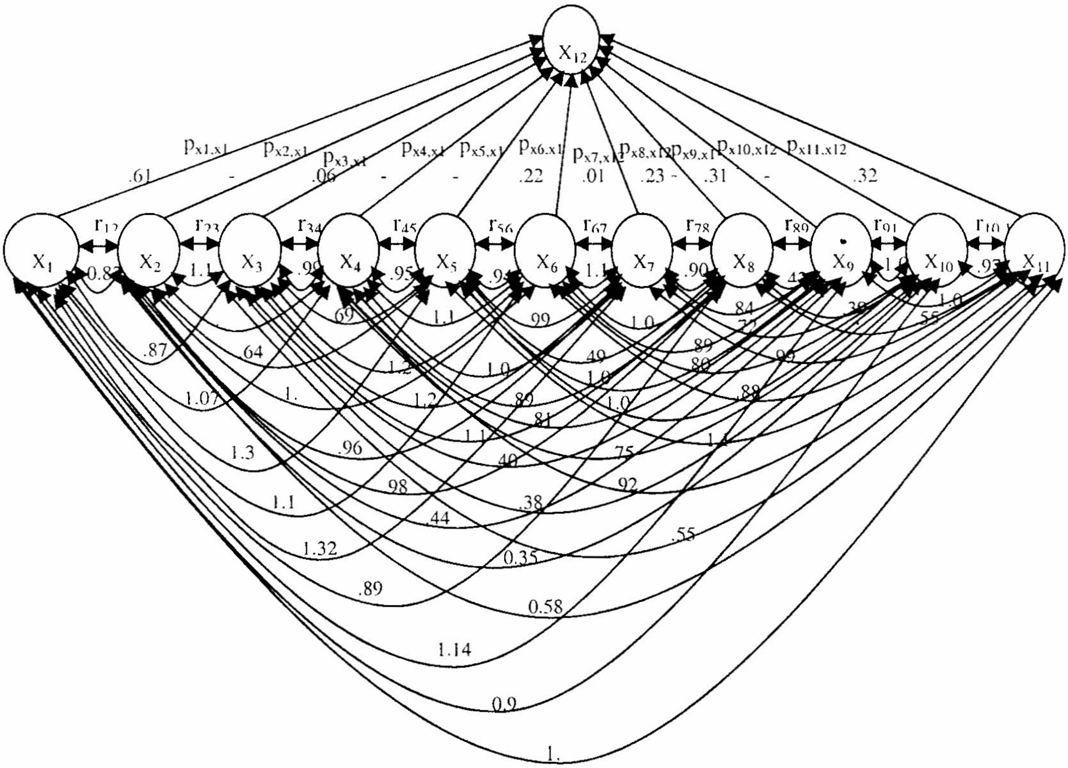
Table 3. Path coefficient analysis showing direct and indirect effects of yield components on yield of lentil at genotypic level.

Characters	SWPP$_{VS}$											Path coefficient
	DFF	**PHFF**	**NPBFF**	**NSBFF**	**NSBMF**	**PAPP**	**PWPP**	**RWPP**	**NPdPP**	**PdWPP**	**NSPP**	
DFF	**0.6131**	0.5004	0.5380	0.6609	0.8068	0.7277	0.8118	0.5514	0.6995	0.5522	0.7769	0.6131
PHFF	-1.3750	**-1.6849**	-1.8826	-1.5697	-1.0875	-1.7117	-1.6216	-1.6632	-0.7486	-0.5829	-0.9825	-1.6849
NPBFF	0.0613	0.0780	**0.0698**	0.0692	0.0448	0.0842	0.0647	0.0787	0.0284	0.0269	0.0388	0.0698
NSBFF	-0.9158	-0.7915	-0.8420	**-0.8496**	-0.8119	-0.9560	-0.9074	-0.7622	-0.6928	-0.6385	-0.7886	-0.8496
NSBMF	-0.7949	-0.3900	-0.3873	-0.5773	**-0.6041**	-0.5695	-0.5997	-0.3006	-0.6603	-0.6083	-0.6910	-0.6041
PAPP	0.0263	0.0226	0.0268	0.0250	0.0209	**0.0222**	0.0235	0.0227	0.0188	0.0179	0.0196	0.0222
PWPP	0.0189	0.0137	0.0132	0.0152	0.0141	0.0151	**0.0142**	0.0128	0.0120	0.0104	0.0136	0.0142
RWPP	2.1003	2.3054	2.6342	2.0951	1.1621	2.3896	2.1046	**2.3355**	1.0191	0.9279	1.3071	2.3355
NPdPP	3.5699	1.3902	1.2716	2.5516	3.4198	2.6545	2.6432	1.3653	**3.1290**	3.2173	3.2412	3.1290
PdWPP	-6.6169	-2.5418	-2.8308	-5.5218	-7.3983	-5.9355	-5.3421	-2.9190	-7.5547	**-7.3472**	-7.1456	-7.3472
NSPP	4.1120	1.8923	1.8051	3.0120	3.7117	2.8653	3.1089	1.8162	3.3615	3.1561	**3.2451**	3.2451
Total effect	0.9395	0.3945	0.4778	0.7168	0.7673	0.8786	0.7375	0.6411	0.8542	0.9232	0.8628	

Residual effect = 1.3822 and **Bold** indicates direct effect.

The characters PHFF, NSBMF, PAPP, RWPP, NPdPP and PdWPP exhibited maximum direct positive effect at phenotypic level and DFF, NPBFF, PAPP, PWPP, RWPP, NPdPP and NSPP had positive direct effect at genotypic level on SWPP. These results were in agreement with Ghafoor *et al.* (1990) in mash, Yaqoob *et al.* (1997) in mungbean, Deb (2003) in chickpea, Hassan *et al.* (2003) in mashbean, Khaliq *et al.* (2004) in bread wheat and Saleem *et al.* (2007) in maize.

DFF, NPBFF, NSBFF, PWPP and NSPP showed negative direct effects at phenotypic level and PHPP, NSBFF, NSBMF and PdWPP had negative direct effect at genotypic level on SWPP. These characters also failed to contribute to yield due to its negative direct effect. Deb (2003) in chickpea, Hassan *et al.* (2003) in mashbean and Sarker and Deb (2006) in blackgram also observed negative direct effect to yield both at phenotypic and genotypic levels. Diz *et al.* (1994) found positive direct effect to yield while working on pearl millet × elephantgrass hybrids.



→ Direct effect

↔ Correlation

Fig. 1. Path diagram of different yield contributing characters on yield at genotypic level.

The path coefficient value of DFF with SWPP was negative at phenotypic level but positive at genotypic level. DFF also showed negative indirect effect on SWPP via NPBFF, NSBFF, PWPP and NSPP at phenotypic level and via PHFF, NSBFF, NSBMF and PdWPP at genotypic level, while rest of the characters exhibited positive indirect effect. PHFF showed negative indirect effect on SWPP via DFF, NPBFF, NSBFF, PWPP and NSPP at phenotypic level and via NSBFF, NSBMF and PdWPP at genotypic level. The rest of the characters showed positive indirect effect. NPBFF showed positive indirect effect on SWPP through PHFF, NSBMF, PAPP, RWPP, NPdPP and PdWPP at phenotypic level and through DFF, PAPP, PWPP, RWPP, NPdPP and NSPP at genotypic level and rest of the characters showed negative indirect effects. NSBFF having negative indirect effect on SWPP via DFF, NPBFF, PWPP and NSPP at phenotypic levels and via PHFF, NSBMF and PdWPP at genotypic levels. The rest of the characters showed positive indirect effect both at genotypic and phenotypic levels. NSBMF having positive indirect effect on SWPP through PHFF, PAPP, RWPP, NPdPP, PdWPP at phenotypic level and via DFF, NPBFF, PAPP, PWPP, RWPP, NPdPP and NSPP at genotypic level and rest of the characters showed negative indirect effect both at genotypic and phenotypic levels. PAPP having positive indirect effect on SWPP via PHFF, NSBMF, RWPP, NPdPP and PdWPP at phenotypic level but this character showed negative indirect effect for PHFF, NSBFF, NSBMF and PdWPP at genotypic level. PWPP having negative indirect effect on SWPP via DFF, NPBFF, NSBFF and NSPP at phenotypic level and via PHFF, NSBFF, NSBMF and PdWPP at genotypic level. The rest of the characters showed positive indirect effects. RWPP showed positive indirect effect on SWPP through PHFF, NSBMF, PAPP, NPdPP and PdWPP at phenotypic level and via DFF, NPBFF, PAPP, PWPP, NPdPP and NSPP at genotypic level, but rest of the characters showed negative indirect effect. NPdPP having negative indirect effect on SWPP via DFF, NPBFF, NSBFF, PWPP and NSPP at phenotypic level and via PHFF, NSBFF, NSBMF and PdWPP at genotypic level and rest of the characters showed positive indirect effect both at genotypic and phenotypic levels. PdWPP having positive indirect effect on SWPP via PHFF, NSBMF, PAPP, RWPP and NPdPP at phenotypic level and via DFF, NPBFF, PAPP, PWPP, RWPP, NPdPP and NSPP at genotypic level, but rest of the characters showed negative indirect effect both at genotypic and phenotypic levels. NSPP having positive indirect effect on SWPP via PHFF, NSBMF, PAPP, RWPP, NPdPP and PdWPP at phenotypic level but this character showed negative indirect effect on SWPP via PHFF, NSBFF, NSBMF and PdWPP at genotypic level. Results obtained, were in agreement with the findings of Alam *et al.* (1988) in *Brassica*, Nahar (1997) in sugarcane, Hussain *et al.* (1997) in chili, Deb (2003) in chickpea, Khaliq *et al.* (2004) in wheat, Sarker and Deb (2006) in blackgram and Saleem *et al.* (2007) in maize.

From the above results, the characters number of pods per plant (NPdPP) and number of seeds per plant (NSPP) have shown considerable direct positive effects on seed yield (SWPP). Positive direct effect of NPdPP and NSPP associated with significant and positive correlation with seed yield. It is concluded that these characters may be good selection criteria to improve the seed yield of lentil.

REFERENCES

Alam, M. S., Das, M. K. and Khair, A. B. M. A. 1988. Genetic variation, correlation and path analysis in *Brassica juncea* (L.). *Bangladesh J. Pl. Breed. Genet.*, 1 (1&2): 116-122.

BBS, 2008. Monthly statistical Bulletin, April, 2008. Bangladesh Bureau of Statistics. Dhaka, Bangladesh.

Deb, A. C. 2003. Study of genetic control, selection index and genotype – environment interaction of yield and yield components in chickpea (*Cicer arietinum* L.), Ph. D Thesis, University of Rajshahi. Bangladesh.

Dewey, D. R. and Lu, K.H. 1959. A correlation and path coefficient analysis of components of crested wheat grass seed productions. *Agron. J.*, 51: 515-518.

Diz, D. A., Wofford, D.S. and Schank, S.C. 1994. Correlation and path-coefficient analyses of seed-yield components in pearl millet x elephantgrass hybrids. *Theor. Appl. Genet.* 89: 112-115.

Ghafoor, A., Zubair, M. and Malik, B.A. 1990. Path coefficient analysis in mash (*Vigna mungo* L.). *Pak. J. Bot.*, 22: 160-167.

Hassan, M., Zubair, M. and Ajmal, S. 2003. Correlation and path coefficient analysis in some promising lines of mashbena (*Vigna mungo*). *Pakistan J. Bio. Sci.* 6(4): 370-372.

Husain, M.M., Khaleque, M.A. and Joarder, O.I. 1997. Inheritance study of yield and yield components using Triple Test Cross (TTC) in chili (*Capsicum annuum* L.). *Bangladesh J. Genet. Biotechnol.*, 1(2): 13-17.

Kang, M.S., Sosa, O. and Miller, J.D. 1989. Path analysis for percent fibre, cane and sugar yield in sugarcane. *Crop Sci.* 29: 1481 - 1483.

Khaliq, I., Parveen, N. and Chowdhry, M.A. 2004. Correlation and path coefficient analyses in bread wheat. *International J. Agric. Bio.* 6 (4):633–635.

Miller, A., Williame, J.C. Robinson, H.F. and Comstock, R.E. 1958. Estimates of genotypic and environmental variances and covariance in upland cotton and their implications in selection. *Agron. J.*, 50: 126-131.

Nahar, S. M. N. 1997. Genetic study of economically important characters and construction of selection index in sugarcane, Ph.D. Thesis, University of Rajshahi, Bangladesh.

Nahar, S. M. N. and Khaleque, M.A. 1996. Variability of F_2 population in sugarcane. In plants for Human Welfare.Proc. 8th Bot. Conf. 12-13 Dec. 1994. Bangladesh Botanical Society, pp. 111-116.

Saleem, A.R., Saleem, U. and Subhani, G.M. 2007. Correlation and path coefficient analysis maize (*Zea mays L.*). *J. Agric. Res.*, 45(3):177-183.

Sarker, N. and Deb, A.C. 2006. Correlation and Path Coefficient analysis in Some yield and yield contributing characters in blackgram [*Vigna mungo* (L.) Hepper], *Bangladesh J. Genet. Biotechnol.*, 7(1&2):19-23.

Singh, K.B. and Malhotra, R.S. 1970. interrelationship between yields and yield components in mungbean, *Indian, J. Genet.*, 30: 244-250.

Yaqoob, M., Khan, H.V., Malik, A.J. Nawab, K. and Malik, B.A. 1997. Path coefficient analysis in some Mungbean [*Vigna radiate* (L.) Wilezek] mutants. *Sarhad J. Agric.*, 13: 277-281.