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Genetic analysis for yield and its components and protein content in table pea (*Pisum sativum*, L. var. hortense)

Brijesh Singh and P. Singh[5]

Department of Genetics & Plant Breeding
S.M.M.Town P.G. College, Ballia, U.P. (India)

Abstract

Six generation (P_1,P_2,F_1,F_2,BC_1 and BC2) of fifteen crosses namely Ajad P_1x Ajad P_2, Ajad P_1 x KS195, Ajad P_1 x KS149, Ajad P1 x KS136, Ajad P1 x Arkel, Ajad P_2 x KS195, Ajad P_2 x KS-149, Ajad P_2 x KS-136, Ajad P_2 x Arkel, KS195 x KS-149, KS195 x KS136, KS195 x Arkel, KS149 x KS 136, KS149 x Arkel, KS136 x Arkel were evaluated for days to flower, plant length, number of green pods per plant, number of seeds per pod, green pod yield and protein content in a randomized block design (RBD). The data of six generation were subjected to scaling test to detect epistasis and genetic parameters m, d, h, i, j and l were estimated. Six parameters analysis revealed that in general dominance (h) was more pronounced than additive (d) in most of the crosses for different traits. It was further observed that character plant length were under major control of either additive or additive x additive gene action. The major role of dominance along with additive x dominance and dominance x dominance components of epistasis for days to flower, number of green pods per plant, number of seeds per pod, protein content and green pod yield per plant. Duplicate epistasis is more prevalent than complimentary type in the inheritance of the traits in this study.

Key words- Table pea, generation means, gene action, yield components, protein content

Introduction

Table pea (*Pisum sativum* L. var hortense) is the most important vegetable crop of India and world. Among Rabi vegetables, table pea holds an important position of its sources of protein, carbohydrate vit-A & C, calcium and phosphorus. On dry weight basis, garden pea (wirnkled seeds) contains 10-13 percent total sugar, 33 percent starch and 26.3 percent protein. Sweet test of table pea depends upon the sugar content. Table pea occupies an area of 282.4 thousand hectare with production of 2706.4 thousand tones and average productivity was 96 tonnes per hectare. The table pea shares about 3 percent of total vegetables. Productivity of table pea is considerably low in comparison to other vegetables because of non availability of high pod yielding short duration, stable and disease resistant varieties. Due to lack of a concrete and holistic research programme in this direction, which is major bottleneck in achieving a breakthrough in vegetable production in general and peas in particular. Besides using improved production technology, breeding high yielding disease resistant and suitable plant types which may be highly responsive to inputs and insensitive to light can help to cross the yield barrier is most urgently

[5] Ex-Professor of Genetics and Plant Breeding, C.S.A. University of Agril. & Technology, Kanpur, India

needed. Hence in the present investigation, an effort has been made to find out the inheritance of yield and its attributes for their further utilization in the breeding programme.

Materials and Methods

Six generations namely P_1,P_2,F_1,F_2, BC_1 and BC_2 of each of these fifteen crosses viz, Ajad P_1 x Ajad P_2, Ajad P_1 x KS-195, Ajad P_1 x KS-149, Ajad P_1 x KS-136, Ajad P_1 x Arkel, Ajad P_2 x KS-195, Ajad P_2 x KS-149, Ajad P_2 x KS-136, Ajad P_2 x Arkel, KS-195 x KS-149, KS-195 x KS-136 , KS-195 x Arkel , KS-149 x KS-136 , KS-149 x Arkel, KS-136 x Arkel were raised in a randomized block design (RBD) with three replications in 3.0 meter long row spaced 50 cm. apart with plant to plant distance 15 cm. The individual data were recorded on randomly selected 10 plants in each parents and F1s and 20 plants in each $BC_1{}^S$, $BC_2{}^S$ and $F_2{}^S$ in each replication on various characters. Date were recorded on days to flower, plant length, number of green pods per plant, length of green pod, number of seeds per pod, green pod yield per plant and protein content. The data were subjected to scaling test to detect the presence of epistasis. In case of significance of scaling test, data were then subjected to estimation of various genetic components as per Hayman (1958). Adequacy of scals denotes the presence of non-allelic interaction. Under such situation six parameters model (digenic epistasis) on the lines given by Hayman (1958) are used as under to know the gene action. For detection of epistasis and genetic parameters m, d, h, i, j, and l were estimated.

Result and Discussion

The estimates of gene effects and interaction for the best fit model with respect to different traits in fifteen crosses of table pea are given in table 1-6. The inheritance patterns varied with crosses and character under consideration. The relative estimates of additive and non-additive gene action (dominance and epistasis interactions) based on six parameters model (table-1) indicated that additive gene effect (d) was predominant in the crosses Ajad P1 x Ajad P2 for days to flower, Ajad P1 x KS 136, Ajad P2 x KS195, Ajad P2 x KS149 and Ajad P2 x KS136 for number of branches per plant, Ajad P2 x KS195 and Ajad P2 x KS 136, Ajad P2 x KS149 and Ajad P1 x KS136 for number of green pod per plant, Ajad P1 x Ajad P2, Ajad P1 x KS149, Ajad P1 x KS136 and KS149 x Arkel for number of seeds per pod; KS195 x Arkel and KS 136 x Arkel for protein content and Ajad P1 x KS149, Ajad P2 x Arkel, KS149 x KS136, KS136 x Arkel and KS195 x Arkel for green pods yield per plant.

The predominance of dominance gene effect (h) was observed in fourteen crosses for late flowering and none of the crosses was found with significant negative value for early flowering. All the fifteen crosses had dominance significant effect with positive value for number of green pods per plant. Crosses Ajad P1 x KS195, Ajad P1 x KS149, KS195 x KS136 and KS195 x Arkel showed significant negative value for reduced plant length. For the trait number of seed per pod six crosses viz Ajad P2 x KS 149, Ajad P2 x Arkel, KS195 x KS 149, KS195 x KS 136, KS195 x Arkel and KS 136 x Arkel showed significant positive values reflecting more number of seeds per pod. Only four crosses Ajad P1 x Ajad P2, Ajad P2 x KS195, Ajad P2 x KS 149 and KS195 x Arkel showed significant positive value for high protein content. For the trait green pod yield per plant Ajad P1 x KS 149 had higher value followed by Ajad P2 x Arkel, KS149 x KS 136, KS136 x Arkel, KS195 x Arkel, Ajad P2 x KS149 and Ajad P1 x KS 136. Over all it was general observation that dominance gene effect was more pronounced than additive effect in most of the crosses for different traits. On the other hand predominance of additive gene effect was noted for days to flower.

Among the components of epistatic interaction dominance x dominance (l) gene effect were more frequent followed by additive x additive (i) and additive x dominance (j) gene effects for most of the characters. The major role of additive x additive (i) gene effect was observed in variable number of crosses viz; five crosses for plant length, all the fifteen crosses for number of green pods per plant, six crosses for number of seeds per pod, three crosses for protein content and fourteen crosses for green pod yield per plant. None of the crosses were significant for days to flower in desirable direction for additive x additive gene effect. The additive x dominance (j) gene effects played significant role in eleven crosses for plant length, seven crosses for protein content, eight crosses for number of green pods per plant, six crosses for green pod yield per plant and two crosses for number of seeds per pod. None of the crosses were significant for days to flower in desirable direction for additive x dominance gene effect. The role of dominance x dominance (l) gene effect were observed in twelve crosses for days to flower, seven crosses for plant length and number of seeds per pod, four crosses each for length of green pod and protein content and two crosses for green pod yield per plant. None of the crosses were desirable with significant values for number of green pods per plant for dominance x dominance gene effects.

In present study the predominance of digenic interaction was observed in desirable direction for most of the crosses such as additive x additive (i) gene effects for plant length, number of green pods per plant, length of green pod and green pod yield per plant. Additive x dominance (j) gene interaction for protein content and dominance x dominance (l) gene interaction were predominant for days to flower and number of seeds per pod. Thus, the average magnitude of different estimates (Table-1) revealed that character plant length were under the major control of either additive or additive x additive gene action. The major role of dominance along with additive x dominance or dominance x dominance components of epistasis and meager role of additive and additive x additive interaction for character days to flower, number of green pod per plant, number of seeds per pod, protein content and green pods yield per plant reflected, the non additive gene action in the inheritance of these traits. The results are in conformity with those of Singh *et.al.* (1987), Singh and Singh (1990), Sirohi *et.al*. (1993).

The opposite signs of h and l components were indicative of duplicate type of epistasis. In the present study the evidence for duplicate type of epistasis had been obtained in thirteen crosses for days to flower and green pod yield per plant, fourteen crosses for plant length, number of green pods per plant, twelve crosses for number of seeds per pod and nine crosses for protein content with the similar signs of h and l one cross each for plant length and number of green pods per plant, two crosses each for days to flower, protein content and green pod yield per plant and three crosses for number of seeds per pod has shown complementary gene interaction. In this study duplicate epistasis was more prevalent than complementary epistasis. It is general observation that duplicate epistasis hinders the progress through selection. However complementary epistasis favors the improvement of traits by hybridization followed by selection. Singh and Joshi (1982), Singh et.al. (1987), Singh and Sharma (2010) have also reported similar findings in field pea.

Table 1. Estimates of gene effects based on six-parameter model for six quantitative characters in table pea

Cross	Genetic parameters					
	^ m	^ d	^ h	^ i	^ j	^ l
	Days to flower					
Azad P1x Azad P2	58.06*±1.06	-5.19** ± 1.03	17.16** ± 4.72	20.68** ± 4.70	-0.53 ± 1.04	-15.66** ± 5.
Azad P1x KS195	62.41**± 0.12	-06.2 ± 0.77	11.45* ± 1.81	12.61** ± 1.62	3.11** ± 0.98	-15.92** ± 3.
Azad P1x KS149	60.10**±1.23	-0.23 ± 0.39	10.12* ± 5.10	11.13** ± 4.99	-0.65 ± 0.87	-20.04** ± 5.
Azad P1x KS136	59.57* ± 0.69	4.83 ± 7.82	14.46** ± 3.25	12.19** ± 8.16	4.37** ± 0.87	-13.62** ± 4.
Azad P1x Arkel	48.50** ± 0.29	13.26** ± 0.58	30.65** ± 2.08	20.35** ± 1.66	7.78** ± 0.88	10.29** ± 3.6
Azad P2x KS195	62.41** ± 0.63	3.48** ± 0.99	10.31** ± 3.28	13.53** ± 3.21	2.88** ± 1.11	-1.93 ± 4.89
Azad P2x KS149	59.04** ± 0.63	8.99** ± 0.50	11.99** ± 3.10	15.98** ± 2.88	3.91** ± 0.93	-12.78** ± 4.
Azad P2x KS136	59.08** ± 0.52	6.31** ± 0.23	13.87** ± 2.48	16.23** ± 2.13	1.20** ± 0.44	-10.35** ± 3.
Azad P2x Arkel	52.75** ± 0.72	4.03** ± 1.09	56.42** ± 3.72	49.20** ± 3.62	6.11** ± 1.26	-51.89** ± 5.
KS149xKS149	63.53** ± 0.37	4.81** ± 0.64	-1.75 ± 2.24	5.05* ± 1.96	0.33 ± 1.12	-16.98** ± 3.
KS195x KS136	61.78** ± 0.25	6.85** ± 1.25	5.84* ± 2.85	11.72* ± 2.68	2.34 ± 1.39	-21.57** ± 5.
KS195x Arkel	51.83** ± 0.67	12.82** ± 0.77	38.80** ± 3.25	39.49** ± 3.09	3.28** ± 1.13	-4.70 ± 4.55
KS149x KS136	56.57** ± 0.79	1.89* ± 0.77	19.49** ± 3.65	22.71** ± 3.52	1.85 ± 1.15	-35.32** ± 4.
KS149x Arkel	50.69** ± 0.95	10.54** ± 2.72	42.93** ± 6.79	34.89 ± 6.64	5.48 ± 2.90	-35.51** ± 1
KS136x Arkel	49.26** ± 0.62	6.00** ± 1.12	37.73** ± 3.47	33.48 ± 3.34	0.98 ± 1.35	-32.92** ± 5.
	Plant length					
Azad P1x Azad P2	145.66**± 2.11	-49.99**±2.24	-3.87±10.04	41.75**±9.56	14.42**±2.66	122.3
Azad P1x KS195	78.12**±0.73	-12.27**± 0.29	-76.51** ± 3.11	-75.92** ± 2.97	-4.65** ± 0.89	156.7
Azad P1x KS149	79.47 ± 1.20	-10.12** ± 0.72	15.67**±5.27	-24.03** ± 5.03	-6.45** ± 0.95	50.77
Azad P1x KS136	77.18** ± 0.86	-11.81** ± 1.31	17.70 ± 4.55	15.32** ± 4.33	-8.52** ± 1.51	-33.34
Azad P1x Arkel	70.28** ± 0.16	0.16 ± 0.81	39.91** ± 1.86	27.96** ± 1.74	-.097 ± 0.97	-29.33
Azad P2x KS195	145.66** ± 2.03	30.89** ± 1.33	58.77** ± 8.90	39.95** ± 8.54	-25.90** ± 1.97	-48.71
Azad P2x KS149	139.83**±0.24	48.88** ± 2.91	95.19** ± 6.73	67.70** ± 5.90	-11.85** ± 3.21	-79.28
Azad P2x KS136	128.66** ±1.24	46.90**±1.09	149.91**±6.29	139.10**±5.42	-14.22**±1.78	-212.3
Azad P2x Arkel	142.70**±1.39	46.62**±2.07	55.85**±7.18	9.45 ± 6.93	-18.93**±2.45	44.31
KS149xKS149	69.77**±0.55	-7.84**±1.10	39.60**±3.26	50.61**±3.11	-11.78**±1.40	-68.90
KS195x KS136	75.03**±0.13	0.53 ± 0.68	-40.78** ± 1.93	-30.42** ± 1.46	-3.80** ± 1.19	71.69
KS195x Arkel	75.07**±6.21	3.27** ± 0.69	-23.90** ± 2.97	-22.07** ± 2.84	-5.48** ± 1.06	54.18
KS149x KS136	72.84** ± 1.02	12.59** ± 0.95	57.80* ± 4.64	49.45** ± 4.52	12.20** ± 1.24	-57.62
KS149x Arkel	67.68** ± 0.39	13.41** ± 1.17	40.72** ± 2.88	32.49** ± 2.82	8.59** ± 1.31	-20.99
KS136x Arkel	78.46** ± 1.33	-3.42** ± 0.59	-11.18* ± 5.59	-22.06** ± 5.47	-7.84** ± 0.94	48.76

Number of green pods per plant

Azad P1x Azad P2	16.55**±0.31	-11.26**±0.73	52.05**±2.07	36.58**±1.93	-11.94**±0.81	-35.20*
Azad P1x KS195	13.58**±0.16	-1.21**±0.22	28.88**±1.05	24.27**±0.79	0.54±0.40	-10.62*
Azad P1x KS149	15.14**±0.20	-15.05**±0.67	85.31**±1.68	81.58**1.55	-19.07**±0.76	-156.3
Azad P1x KS136	8.62**±0.12	8.12**±0.99	44.34**±2.09	43.29**±2.03	8.27**±1.06	-42.34*
Azad P1x Arkel	12.49**±0.20	1.67±0.87	19.83**±1.96	13.55**±1.92	0.39±0.93	6.43±3
Azad P2x KS195	21.32**±0.76	20.32**±0.51	35.18**±3.44	26.15**±3.21	22.75**±0.56	-39.24*
Azad P2x KS149	12.23**±0.94	12.39**±0.40	57.68**±3.86	46.15**±3.85	9.04**±0.49	-60.95*
Azad P2x KS136	13.39**±0.51	15.92**±0.45	45.44**±2.48	32.98**±2.24	16.75**±0.56	-20.69*
Azad P2x Arkel	17.51**±0.54	-12.71**±1.41	95.81**±3.64	71.54**±3.56	-13.30**±1.43	-96.43*

KS195xKS149	13.63**±0.43	0.61*±0.29	34.24**±1.89	36.55**1.81	-5.17**±0.41	-65.29*
KS195x KS136	13.35**±0.46	-3.04**±0.23	34.62**±1.93	40.17**±1.89	-4.64**±0.40	-61.21*
KS195x Arkel	16.53**±0.54	3.06**±0.21	59.35**±2.31	59.91**±2.21	1.83**±0.30	109.18
KS149x KS136	10.53**±0.26	2.67**±0.96	56.08**±2.24	54.55**±2.17	6.84**±1.03	-87.67*
KS149x Arkel	16.10**±0.06	-0.89*±0.45	31.91**±1.07	25.00**±0.94	1.85**±0.53	-45.77*

Protein Content

Azad P1x Azad P2	5.91** ± 0.01	-0.06 ± 2.02	0.22* ± 0.11	0.15 ± 0.10	0.04 ± 0.05	-0.13 ±
Azad P1x KS195	6.27** ± 0.03	-0.007 ± 0.04	-0.47** ± 0.13	-0.56** ± 0.13	0.48** ± 0.04	1.40**
Azad P1x KS149	6.47** ± 0.01	-0.42** ± 0.02	0.04 ± 0.08	-0.03 ± 0.07	0.21** ± 0.03	0.08 ±
Azad P1x KS136	6.69** ± 0.02	-0.56** ± 0.17	0.02 ± 0.17	-0.09 ± 0.16	0.31** ± 0.17	0.35 ±
Azad P1x Arkel	6.22** ± 0.02	-0.27** ± 0.04	-0.02 ± 0.12	-0.05 ± 0.12	0.11** ± 0.04	0.08 ±
Azad P2x KS195	6.38** ± 0.01	-0.26** ± 0.02	0.26** ± 0.09	0.21* ± 0.09	0.12** ± 0.04	-0.22 ±
Azad P2x KS149	6.08** ± 0.009	-0.37** ± 0.02	1.30** ± 0.17	1.89** ± 0.06	-0.003 ± 0.16	-2.43**
Azad P2x KS136	7.20** ± 0.03	-0.51** ± 0.05	-1.12** ± 0.14	-1.55** ± 0.14	0.26** ± 0.05	2.26**
KS195x Arkel	6.62** ± 0.09	0.13** ± 0.03	0.45** ± 0.08	0.45** ± 0.87	0.02 ± 0.03	-0.65**
KS149x KS136	7.49** ± 0.008	-0.13** ± 0.04	-0.52** ± 0.09	-0.74** ± 0.08	0.09* ± 0.04	1.19**
KS136x Arkel	7.52** ± 0.04	0.32** ± 0.06	-1.16** ± 0.21	-1.64** ± 0.21	-0.16** ± 0.06	2.48**

Number of seeds per pod

Azad P1x Azad P2	6.47**±.0.13	0.40**±0.28	0.07±0.63	-0.67±0.56	-1.58**±0.22	1.13±0.
Azad P1x KS195	6.73**±0.27	-0.30*±0.14	-0.87±1.14	-1.54±1.10	-1.24**±0.22	5.76**±
Azad P1x KS149	8.27**±0.04	0.10*±0.04	-1.64**±0.43	-2.09**±0.30	0.30±0.22	4.78**±
Azad P1x KS136	7.67**±0.07	-0.50**±0.07	-0.01±0.47	-0.87±0.52	-0.49±0.25	2.81**±
Azad P1x Arkel	7.32**±0.05	-0.10±0.18	-0.19±0.62	-2.69**±0.41	-1.06**±0.29	5.74**±
Azad P2x KS195	5.73**±0.02	-0.60**±0.16	0.12±0.42	-0.51±0.34	0.43*±0.19	1.89*
Azad P2x KS149	5.82**±0.15	0.11±0.22	2.99**±0.75	2.28**±0.72	2.27**±0.24	-1.46±
Azad P2x KS136	6.20**±0.12	0.38*±0.17	0.37±0.6	-0.37±0.57	2.35±2.44	1.53±
Azad P2x Arkel	4.40**±0.23	-0.81**±0.18	7.49**±1.83	6.69**±0.99	0.19±0.24	-9.11*
KS149xKS149	6.69**±0.17	-1.47**±0.08	3.43**±0.73	3.67**±0.72	-0.33**±0.10	-5.48*
KS195x KS136	6.60**±0.06	-2.80±0.12	1.93**±0.41	1.87**±0.34	-1.87**±0.20	-1.73*
KS195x Arkel	5.80**±0.12	-0.08±0.09	2.53**±0.52	1.76**±0.50	-0.11±0.16	-0.79±
KS149x KS136	7.60**±0.01	-0.37**±0.07	-0.99**±0.36	-0.85**±0.15	-0.57**±0.18	3.85*
KS149x Arkel	7.10**±0.10	0.33**±0.08	-3.23**±0.50	-2.40**±0.43	-0.83**±0.16	5.67*
KS136x Arkel	6.20**±0.11	1.33**±0.11	4.02**±0.63	4.25**±0.51	0.36±0.23	-5.64*

Green Pod yield per plant

Azad P1x Azad P2	77.09** ± 0.64	-56.45** ± 2.02	191.05** ± 5.01	135.43** ± 4.78	-71.09** ± 2.46	-151.3
Azad P1x KS195	82.73** ± 1.46	-30.39** ± 0.29	91.06** ± 6.12	70.05** ± 5.86	-18.78** ± 1.59	-7.37
Azad P1x KS149	104.34** ± 1.35	116.18** ± 4.41	546.68**±10.62	516.87**±10.35	-113.11**±4.58	1003.9
Azad P1x KS136	51.72** ± 0.15	44.24** ± 1.37	226.15** ± 3.51	217.21** ± 2.81	49.15* ± 19.73	-228.5
Azad P1x Arkel	59.53** ± 0.44	5.34** ± 0.86	106.55** ± 3.70	77.37** ± 2.46	-4.03** ± 1.49	3.25±
Azad P2x KS195	123.54** ± 0.78	64.71**± 1.87	-14.05** ± 5.35	-46.66**± 4.87	90.97** ± 2.26	27.41
Azad P2x KS149	53.18** ± 1.06	30.24** ± 3.13	252.05** ± 7.71	212.78** 7.47	47.96**±3.24	-230.8
Azad P2x KS136	70.33** ± 0.36	58.75**±1.82	174.48**±4.91	133.04**±3.92	78.32**±2.12	-128.2
Azad P2x Arkel	54.59**±0.87	-68.29**±3.43	530.89**±7.82	486.32**±7.70	-63.01**±3.53	-823.7

KS149xKS149	75.33**±0.37	-70.44**±2.11	218.53**±4.63	230.52**±4.47	-78.98**±2.37	-352.4
KS195x KS136	83.50**±0.86	-53.54**±2.54	208.06**±6.46	215.68**±6.16	-60.23**±2.86	-339.3
KS195x Arkel	62.31**±0.64	19.06**±2.02	346.41**±5.06	330.07**±4.79	-1.92±2.29	-492.5
KS149x KS136	75.91**±2.96	-0.36 ± 2.01	289.23**±12.54	312.01**±12.51	1.49±2.19	-606.0
KS149x Arkel	87.16**±1.06	4.98**±1.80	141.51**±5.62	110.49**±5.57	7.46**±1.87	-157.5
KS136x Arkel	53.67**±0.16	47.70**±2.32	358.01**±5.34	332.03**±4.69	33.41**±2.48	-469.3

* Significant at 5 per cent level, ** significant at 1 per cent level, D= Duplicate, C= complementary, m - mean, d = additive gene effects.
h- dominant gene effects, i = additive x additive gene interaction, j = additive X dominance gene interaction and l = dominance x dominance gene

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Quarter symmetric connection in a conformal K – contact Riemannian Manifold

Sunil K. Srivastava* and Amit Prakash

Department of Mathematics and statistics
Faculty of Science, D.D.U. Gorakhpur University,
Gorakhpur (273009)(U.P.), India

Abstract

In 1975, Golab, S introduced the notion of quarter-symmetric connection in a Riemannian manifold with affine connection. Further it was developed by Biswas, S.C., De,U.C. and other geometers. In this paper we have studied quarter symmetric connection in a conformal K – contact Riemannian manifold.

Keywords- Quarter symmetric, conformal K – contact, Riemannian Manifold

1. Introduction

Let us consider an n – dimensional differentiable manifold M^n of differentiability class C^r indowed with a tensor field F of the type (1,1), a 1 – form u and a vector field U, satisfying.

$$\bar{\bar{X}} = -X + u(X)U \,, \tag{1.1 (a)}$$

where

$$\bar{X} = F(X). \tag{1.1(b)}$$

$$\text{rank } F = n-1 \;\; , u = 0 \,, u(\bar{X}) = 0 \;\; , \; u(U) = 1 \tag{1.2}$$

then M^n is said to be an almost contact manifold with contact structure (F, u, U).

Let there be defined in an almost contact manifold M^n, a metric tensor g satisfying

$$g(\bar{X}, \bar{Y}) = g(X, Y) - u(X)u(Y), \tag{1.3 (a)}$$

where

$$u(X) = g(X, U), \tag{1.3 (b)}$$

then the manifold is called almost contact metric manifold.

If we put

$$`F(X,Y) = g(\bar{X}, Y). \tag{1.4}$$

Then using (1.1)(a), (1.2), (1.3) and (1.4), we have

$$`F(\bar{X}, \bar{Y}) = -g(X, \bar{Y}) = g(\bar{X}, Y) = `F(X, Y), \tag{1.5 (a)}$$

$$`F(X,Y) + `F(Y,X) = 0. \tag{1.5(b)}$$

If in an almost contact metric manifold

* E-mail: apoct0185@rediffmail.com, Sunilk537@gmail.com