Bulgarian Journal of Ecological Science

Volume VII Number 1 2008

CIRCULATION OF JOURNAL OF ECOLOGY AND FUTURE

(BULGARIAN GOURNAL OF ECOLOGICAL SCIENCE), ABROAD FOR 2008

BELGIUM - Faculte des Sciences Agronomiques

CANADA - Canadian Agriculture Library

CZECH REPUBLIC - Ustav Vedeckotechnickych Informaci pro Zemedelstvi

FRANCE - Biblioteque National de France

GERMANY - Zentrale Informationsstelle un Bibliotek

HUNGARY - Magyar Tudomanyos Academia

ITALY - Instituto Agronomico per Loltremare

JAPAN - Japan Plant Protection Association

PORTUGAL - Instituto Superior de Agronomia

RUSSIA - Russian Academy for Agrarian Sciences

RUSSIA - Russian National Library

RUSSIA - Siberia National Scientific and Technical Library - Department of Russian Academy of Sciences

Russia - Russian National Institute for Scientific and Technical Information

SPAIN - Centro de Ciencias Medioambientales

SWITZERLAND - Station Federale de Recherches en Production Vegetale

UNITED KINGDOM - Accession Unit CAB International

UKRAINE - National Academy of Sciences

U. S. A. - The Center for Research Libraries

U. S. A. - The New York Botanical Garden

Publishing Department of Scientific Issues
Editor-in-Chief
V. Nenova
Mobile: (+359 898) 514 183
Deputy-in-Chief
S. Parvanova
Phone: (+359 878) 976 250

BULGARIAN JOURNAL
OF ECOLOGICAL SCIENCE
ECOLOGY AND FUTURE ®
2008
c/o Jusautor, Sofia

Association Ecological Alliance
Strelbishte, bl. 2B, entr. B, entry 12,
1404 Sofia, Bulgaria

Information and contacts:
Mobile: (+359 898) 514 183
E-mail: nenova_v@ abv.bg

ISSN 1312 - 076X

ECOLOGY AND FUTURE

Bulgarian Journal of Ecological Science
(The journal is published four times a year)

GENERAL INFORMATION

The journal has been registered as a scientific one of Association Ecological Alliance, dealing with complex researches on ecological problems, forecast-, long-term- and global ecological projects intended for enduring solutions of ecological problems, as well as for practical-and-technological solutions of the same ones, consistent with the world official ecological strategy and policy. Workings out are also to be published related to introduction of ecological technologies, products and productions on the basis of ecological monitoring, ecological models and forecasts, ecological cadastre and ecological identification, as well as of scientific projects with priority in the field of agriculture and forest stock, being important factors for the total stable development. Models of efficient new systems of scientific information are to be also published and used under making technological solutions of tasks connected with environment protection and ecologization of modern material production. Titles of scientific developments and projects of author teams will be also published, aimed at exchanging scientific information, as well as proposals for co-investigations.

Ecology and Future will be published fully in English language, and basically designed for science-related audience abroad.

The journal will be presented in conformity with the requirements to scientific issues and publications will be valid under attainment of academic ranks.

The journal will be distributed by subscription in Bulgaria and abroad, as well as through international book exchange.

Requirements of the Editorial Board

Authors should submit one copy of their article sent along with a diskette to the Editorial Board for reviewing. The scientific work volume is not restricted but the text should be according to the standard (30 typing lines of 65 points each line).

Charge for publication - 4 EURO per type scripted page. Subscription price is 160 EURO per year.

ECOLOGY AND FUTURE, VOL. VII, No 1
Bulgarian Journal of Ecological Science
Sofia. 2008

VERICA ILIEVA, CANE STOJKOVSKI*, SONJA IVANOVSKA*, DOBRE ANDOV, DANICA ANDREEVSKA****
*Faculty of Agriculture – Shtip, *Faculty of Agriculture – Skopje, Institute of Agriculture – Skopje, **Rice Department – Kocani, Macedonia*

Diallel Analysis for Productive Tillering in Rice

Abstract

The mode of inheritance and gene effect for productive tillering of 7×7 half diallel crosses of rice varieties was evaluated in the F_1 and F_2. The mode of inheritance analyzed for each combination separately was different and depended on the hybrid combination. Both, the additive and non-additive genes determined the expression of the trait. The regression analysis (Vr/Wr) showed an absence of interallelic interaction between the genes. In both hybrid generations over dominant inheritance was indicated by the regression line that cuts the Wr axis below the origin.

Key words: diallel crosses, productive tillers, varieties

Introduction

In order to achieve maximum productive potential in some of the grains, breeders are recommending one tiller per plant at optimum number of plants per unit area. In rice at higher sowing density which is necessary to obtain higher yield, the varieties with higher tillering potential, abundantly will develop several stems per plant, but will still have higher total yield than the varieties with lower tillering (Jennings et al., 1979).

The lack of plants in the crop no matter the reasons is better compensated by the rice varieties which have the ability for higher tillering. The number of productive tillers during the development of plant type with abundant tillering is not highly heritable and mostly depends on the applied growing measures. Thus, it is desirable to determine the genetic contribution for this trait even in the first hybrid generations.

Although often associated with early vigor in short-stature materials, tiller number is inherited independently of all other major characters. Beside the positive correlation of the yield to high tillering, the tillering ability does not decrease with the decrease of height in such plants, through hybridization, but can increase even more (Jennings et al., 1979).

Having in mind the above, this investigation was undertaken to explain the nature of effect of tillering genes. In order to achieve better choice of parents for the future rice hybridization programs and a sustainable selection of promising lines for this trait, in the later generations, the general and specific combining abilities were investigated.

Material and Methods

Seven rice varieties (*Oryza sativa* L.), type japonica and the F_1 and F_2 hybrid progenies obtained by their diallel crossing (without the reciprocal combinations) were used as a trial material in this experiment. Two of the crossed varieties are domestic (Biser-2 and Ranka) and five are introduced (Medusa, S-136, Arborio Bjanko, Baldo and Loto).

The seeds from each main panicle of the parental varieties and hybrid combinations were planted in 2000, in special dishes in a greenhouse. The transplanting was carried out at the 2-3 leafs stage in field conditions.

The comparative trial was conducted at the trial of Rice Department-Kocani, Agricultural institute, Skopje, by using randomized block design in three replications. The length of the rows was 1 m with 17 cm space between rows and 20 cm space within rows.

The standard growing measures were applied during the vegetation. After the harvest 30 plants of each F_1 combination, 99 plants of each F_2 combination and 48 plants of each parental variety were analyzed in laboratory conditions. The obtained results were analyzed by simple analysis of variance. The mode of inheritance in the F_1 and F_2 progenies was evaluated by the test of significance of the

mean values of the hybrid generation according the parental ones (Borojević, 1965). The analysis of the general combining ability (GCA) and the specific combining ability (SCA) was carried out according to Griffing (1956), method II, model I. The components of genetic variances and regression analysis were analyzed by using methods of Jinks (1954), Hayman (1954) and Mather and Jinks (1971).

Results and Discussion

From the results presented in Table 1 it can be seen that among the parental varieties Loto has the highest average number of productive tillers (10.13) and Baldo has the lowest one (6.92). The hybrid combination obtained by crossing of these two varieties (Baldo × Loto) has the lowest average value in F_1 generation. The highest number of productive tillers in F_1 was obtained in the combination Medusa × Ranka (10.97). The average values among the in F_2 combinations, presented in Table 2, ranged from 6.75 (S-136 × Loto) up to 10.18 (Biser-2 × Medusa).

The mode of inheritance of the analyzed trait in most of the combinations coincides in both hybrid generations. The number of productive tillers in most of them was dominantly inherited.

The parents with higher average value were dominant in 6 combinations in F_1 generation, and in 5 combinations parent with lower average value was dominant. Signifi cantly higher number of productive tillers compared to both parents or positive heterosis had 4 hybrid combinations, out of which three are obtained by crossing of Medusa (Medusa × A. Bjanko, Medusa × Ranka and Medusa × Baldo). The average values of the other 6 combinations did not significantly differ from the values of their parents (Table 1).

Dominance of one of the parents appeared in 12 F_2 combinations, out of which in 6 combinations parent with higher productive tillers was dominant. In the other 6 combinations parent with lower average value dominated (Table 2). For the 3 of them, mutual parent was variety Ranka and for the other 3 combinations it was variety Loto. Positive heterosis in this generation had only the combination Medusa × Baldo. The mode of inheritance was intermediary in the combination Biser-2 × A. Bjanko and partially

Table 1. Mean values and the inheritance of productive tillering in rice (parents and F_1)

Parents	Biser-2	Medusa	S-136	A. Bjanko	Ranka	Baldo	Loto
Biser-2	**9.40**	9.00 $^{+d}$	7.87 $^{-d}$	7.80 $^{-d}$	8.83	9.80 $^{+d}$	9.67
Medusa		**7.63**	7.90	9.03 $^{+h}$	10.97 $^{+h}$	9.30 $^{+h}$	10.83 $^{+d}$
S-136			**7.65**	8.93 $^{+h}$	7.90 $^{-d}$	7.40	8.07 $^{-d}$
A.Bjanko				**7.21**	9.10 $^{+d}$	7.33	8.90 $^{+d}$
Ranka					**9.29**	9.03 $^{+d}$	9.33
Baldo						**6.92**	7.20 $^{-d}$
Loto							**10.13**

d – dominant; h – heterosis.

$LSD_{0.05}$ = **1.19**

$_{0.01}$ = **1.58**

Table 2. Mean values and the inheritance of productive tillers per plant (parents and F_2)

Parents	Biser-2	Medusa	S-136	A. Bjanko	Ranka	Baldo	Loto
Biser-2	**9.40**	10.18 $^{+d}$	8.98 $^{+d}$	8.30 ^{i}	9.77	8.97 $^{+d}$	8.36 $^{-d}$
Medusa		**7.63**	8.42	7.60	8.16 $^{-d}$	8.82 $^{+h}$	8.53 $^{-d}$
S-136			**7.65**	7.21	8.10 $^{-o}$	7.90 $^{+d}$	6.75 $^{-d}$
A.Bjanko				**7.21**	8.55 $^{+d}$	7.53	9.82 $^{+d}$
Ranka					**9.29**	7.91 $^{-d}$	9.05
Baldo						**6.92**	7.81 $^{-pd}$
Loto							**10.13**

d – dominant; h – heterosis; i – intermediary; pd – partially dominant.

$LSD_{0.05}$ = **1.19**

$_{0.01}$ = **1.58**

dominant in Baldo × Loto. Having in mind that additive gene effect could be fi xed in the further generations, these combinations will be treated with special interest in the further breeding. Same as in F_1, the mean values in 6 combinations did not show significant difference compared to their parents.

The results from our investigation are in agreement with the fi ndings of Roy and Panwar (1993) where dominance of both better and worse parent was obtained, and with the results of El-Hity and Abdel-Hamid (1993) where positive heterosis was determined.

Combining Ability

The obtained results of the analysis of variance (Table 3) show that the variances of the general and specific combining ability are highly significant in both hybrid generations. This means that the expression of productive tillering is a result of both additive and non-additive type of gene actions.

Table 3. ANOVA for combining ability in the F_1 and F_2

Sources of variance	Degrees of freedom	Fe	
		F_1	F_2
GCA	6	14.14**	12.28**
SCA	21	4.67**	3.79**
E	54		
GCA/SCA		**3.03**	**3.24**

The ratio GCA/SCA show that the additive gene action is more than 3 times higher than the non-additive one in both generations, which means that the recessive genes dominantly infl uenced for the expression of this trait.

Table 4. General combining ability of the parents

Perents	GCA - F_1	Range	GCA - F_2	Range
Biser-2	0.20	4	0.65**	1
Medusa	0.35	3	-0.01	4
S-136	-0.64	7	-0.48	7
A. Bjanko	-0.40	5	-0.40	5
Ranka	0.51**	2	0.35	3
Baldo	-0.58	6	-0.47	6
Loto	0.57**	1	0.40*	2
SE	0.20		0.19	
$LSD_{0.05}$	**0.40**		**0.37**	
$_{0.01}$	**0.50**		**0.49**	

The signifi cant values of GCA and SCA were supported by several scientists like Lokaprakash et al. (1991), Ramalingam et al. (1993), Singh et al. (1993), Kim and Lee (1994), Geetha et al. (1994) and Bansal et al. (2000). All of them reported advantage of dominant genes and only Singh et al. (1993) find out almost equal exploitation of both components. In the results reported by Kumar and Chandrappa (1994) additive gene action had primary influence and the SCA value was negative. The additive genes had a higher role in the inheritance in the findings of Singh et al. (1980) as well, but only in F_2, while in the F_1 generation they GCA had negative value. Importance of additive genes for expression of varia-

Table 5. Specific combining ability of the hybrid combinations

Hybrid combinations	SCA	SCA
	F_1	F_2
Biser-2 × Medusa	-0.19	1.19*
Biser-2 × S-136	-0.34	0.47
Biser-2 × A. Bjanko	-0.64	-0.29
Biser-2 × Ranka	-0.52	0.43
Biser-2 × Baldo	1.54**	0.45
Biser-2 × Loto	0.25	-1.03
Medusa × S-136	-0.45	0.54
Medusa × A. Bjanko	0.44	-0.38
Medusa × Ranka	1.46**	-0.55
Medusa × Baldo	0.89	0.92
Medusa × Loto	1.27*	-0.24
S-136 × A.Bjanko	1.34*	-0.28
S-136 × Ranka	-0.61	-0.14
S-136 × Baldo	-0.02	0.48
S-136 × Loto	-0.50	-1.54
A. Bjanko × Ranka	0.35	0.22
A. Bjanko × Baldo	-1.47	-0.85
A. Bjanko × Loto	0.09	1.45**
Ranka × Baldo	0.46	-0.34
Ranka × Loto	-0.39	-0.07
Baldo × Loto	-1.43	-0.49
SE	0.52	0.49
$LSD_{0.05}$	**1.05**	**0.98**
$_{0.01}$	**1.39**	**1.31**

tion of productive tiller number per plant has been reported by Mahmood et al., (2004).

The estimated GCA values of the parents are shown in Table 4. Range distribution of the best and worst combiners for this character was different in the two investigated generations. Among the investigated parents 4 varieties are good combiners with positive GCA values. Only three of them, Loto and Ranka in F_1 and Biser-2 in F_2, had highly significant GCA values, while Loto in F_2 had significant value.

According to the results presented in Table 5, positive SCA values had 10 combinations in F_1 and 9 in F_2 generation. However, in F_1 only 2 of these values were hihgly significant and other 2 were significant, while in F_2 only the combinations Biser-2 × Medusa and A. Bjanko × Loto had highly significant values. All of them were obtained by crossing of one good and one bad combiner, except the combinations Biser-2 × Baldo and S-136 × A. Bjanko, where both parents had bad to medium good GCA values. The obtained good SCA values in these two crosses apply only to the concrete combinations and it does not have to mean that the same will be achieved in crosses of these varieties with other combiners.

Regression Analysis

The regression analysis for productive tillering (Figure 1 and 2) show an absence of interallelic interaction, because the F_1 and F_2 regression coefficients b = 0.606 ± 0.191 and b = 0.716 ± 0.491, respectively, statistically differed from 0.

In the F_1 generation, the regression line was quite

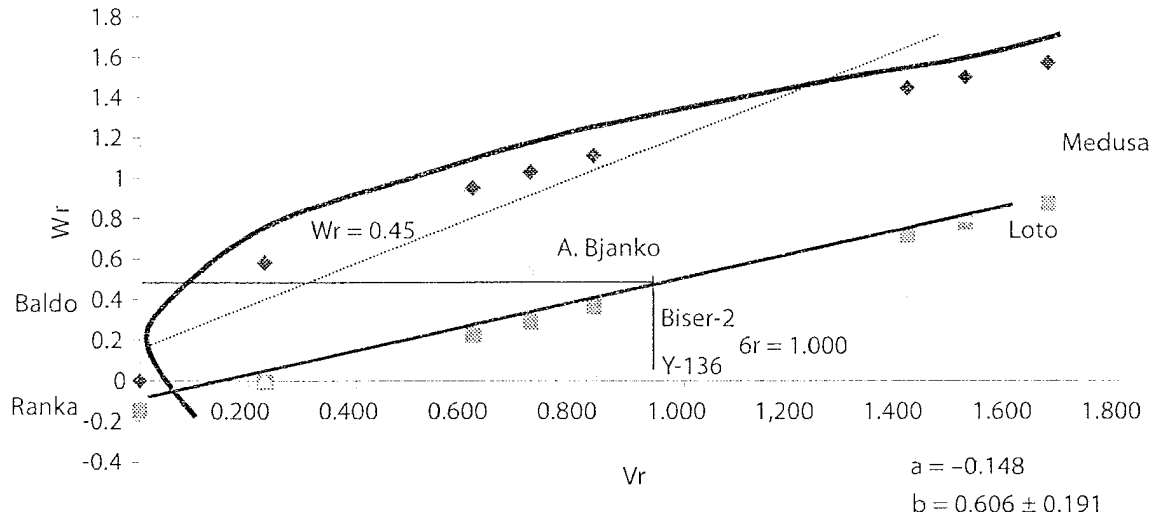

Fig. 1. Vr/Wr regression for productive tillers per plant in rice in the F_1 generation

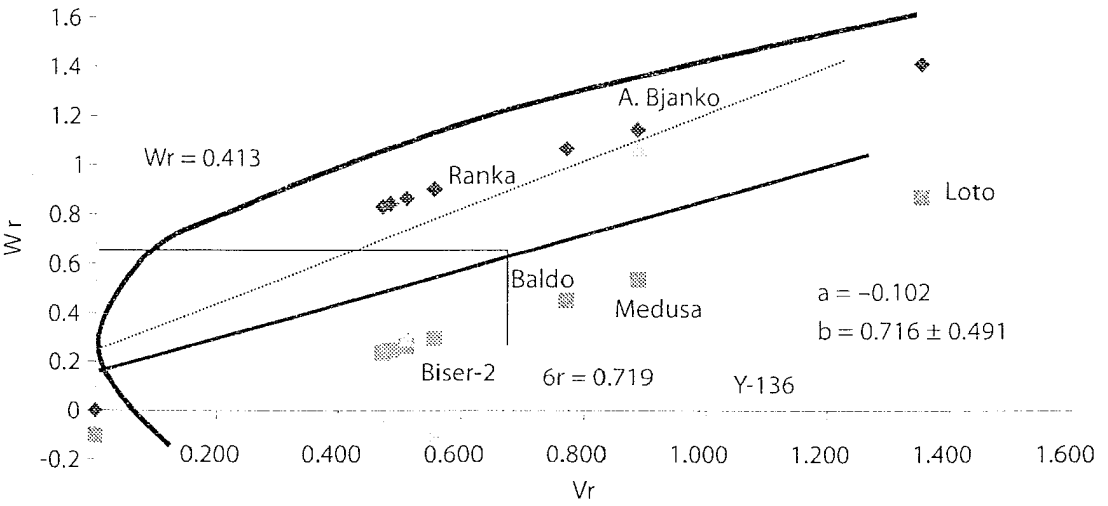

Fig. 2. Vr/Wr regression for productive tillers per plant in rice in the F_2 generation

separated from the limiting parabola indicating bigger role of the dominant genes compared to the recessive ones. These results correspond with the results calculated for each combination separately where most of the inheritance in most of the combinations was dominant.

The position of the regression line that cut the Wr axis below the point of origin indicated over dominant inheritance for this character. Most of the parents are located closer to the axis starting point, which means that they contributed mainly with dominant genes for the expression of the trait.

The variety S-136, according to its position possessed an excess of dominant genes over recessive, while the variety Medusa which array was positioned far away from the origin had the highest quantity of recessive genes, compared to the other varieties. The varieties Biser-2, A. Bjanko and Ranka possess more dominant and Baldo and Loto more recessive genes.

The position of the regression line in F_2 is the same as in F_1 generation. According to the dispersion of the arrays that correspond to parents, most of the parental varieties carry dominant genes. Their quantities in the varieties S-136 and Biser-2 were decreased in F_2, and in Ranka and Baldo were increased. In relation to F_1 the quantity of recessive genes had increased in the varieties A. Bjanko and Loto, while the variety Medusa had less ones.

The parental varieties included in this experiment significantly differed among themselves according to their productive tillering. The variety Loto had highest number of productive tillers per plant (10.13) and Baldo lowest (6.92).

The mode of inheritance in F_1 and F_2 depended on the hybrid combination. In both generations, the inheritance was mostly dominant.

The inheritance of productive tillering was influenced by both additive and non-additive gene effect according to highly significant GCA and SCA values obtained by analysis of variance for combining ability. The additive gene action was about 3 times bigger than the non-additive.

Best general combiners in F_1 generation were varieties Loto and Ranka, and in F_2 Biser-2 and Loto. Positive SCA value had almost half of the combinations in both generations, but only few of them were significant. The highest SCA in the F_1 generation was achieved by the combination Biser-2 × Baldo, and in the F_2 by A.Bjanko × Loto.

Conclusion

The regression analysis (Vr/Wr) showed absence of interallelic interaction for productive tiller number per plant.

In both hybrid generations the regression line cut the Wr axis below the origin, that indicated over-dominant inheritance.

The varieties S-136, Biser-2, A. Bjanko and Ranka possessed higher number of dominant genes for the number of productive tillers, while Medusa, Baldo and Loto had more recessive genes.

References

Bansal, U. K., Saini, R. G., Rani, N. S. 2000. Heterosis and combining ability for yield, its components and qualyti traits in some scented rices (*Oryza sativa* L.). ***Tropical agriculture***, Vol. 77, No 3, 180-187

Borojević, S. 1965. Način nasleđivanja i heritabilnost kvantitativnih svojstava u ukrštanjima raznih sorti pšenice. Savremena poljopivreda 7-8, 587-607; Beograd.

El-Hity, Abdel-Hamid, M. 1993. Genetic analysis of grain yield and related traits in rice (*Oryza sativa* L.). ***Alexandria Journal of Agricultural Research***, 38 (1), 105-122

Geetha, S., Soundararaj, A. P. M. K., Palanisamy, S., and Kareem, A. A. 1994. Combining ability analysis and gene action relating to grain characters among medium duration rice genotypes. ***Crop Research*** (Hisar), 7 (2), 239-242; Aduthurai.

Griffing, B. 1956. Concept of general and specific combining ability in relation to diallel crossing system. ***Aust. J. Biol. Sci.***, 9, 463-493

Mahmood, T., Tumer, M., Stoddard, F. L., Javed, M. A. 2004. Genetic analysis of quantitative traits in rice (*Oryza sativa* L.) exposed to salinity. ***Australian Journal of Agricultural Research***, Vol. 55, No 11, 1173-1181

Ramalingam, J., Vivekanandan, P., and Vanniarajan, C. 1993. Combining ability analysis in lowland early rice. ***Crop Research*** (Hisar) 6 (2), 228-233; Agricultural College and Research Institute, Madurai.

Roy, A., and Panwar, D. V. S. 1993. Nature of gene interaction in the inheritance of quantitative characters in rice. ***Annals of Agricultural Research***, 14 (3), 286-291; Department of Plant Breeding, Haryana Agricultural University, Hisar.

Singh, A., Singh, R., and Panwar, D. V. S. 1993. Combining ability estimates in rice (*Oryza sativa* L.). ***Agricultural Science Digest*** (Karnal), 13, (3/4), 173-176

Singh, S. P., Singh, H. G., and Singh, A. K. 1980. Combining ability trough Line × Tester analysis in rice. ***Genetika***, Vol. 12, No. 3, 303-312

Jennings, P. R., Coff man, W. R., and Kaufman, H. E. 1979. Rice improvement. IRRI. Los Banos, Laguna, Philippines,186 pp.

Jinks, J. L. 1954. The analysis of continuous variation in a diallel cross of Nicotiana rustica varieties. ***Genetics***, 39, 767-789

Kim, C. K., and Lee, B. W. 1994. Growth characteristics and grain yield of F_1 hybrids, their restorers and maintainers in rice. ***Korean Journal of Crop Science***, 39 (3), 262-269

Kumar, B. M. D. and Chandrappa, H. M. 1994. Combining ability studies for yield and its components in rice. ***Mysore Journal of Agricultural Sciences***, 28 (3) 193-198

Lokaprakash, R., Shivashankar, G., Mahadevappa, M., Gowda, B. T. S., and Kulkarni, R. S. 1991. Combining ability for yield and its components in rice. ***Oryza***, 28 (3), 319-322

Mather, K., and Jinks, J. L. 1971. Biometrical genetics. Sec. Ed., Chapman and Hall, London.

Hayman, B. I. 1954. The theory and analysis of diallel crosses. ***Genetics***, 39, 789-809

Sawant, D. S., Patil, S. L., and Bhave, S. G. 1994. Association of grain yield with other characters in segregating generation of rice. ***Annals of Agricultural Ressearch***, 15 (1), 60-63