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PREFACE

The 3rd International Symposium for Sustainable Humanosphere 2013 attracted the interest of scientists from Indonesia and Japan. The symposium covered the disciplines of community-based development and social economic science (climate change and society; ecosystem and community; the economical of natural resources; the role of traditional knowledge and values in managing ecosystems; women and natural resources), atmospheric science (airpollution; equatorial atmosphere; global climate change models; land-ocean weather systems; radar observations; solar activities; space environment; weather patterns), biosphere science (agricultural in changing world; animal ecology and animal husbandry; anthropological approach; bio-indicator; ethnobotany; food security; human development index), geosphere science (earth geological dynamics and natural disasters; earth carbon cycle dynamics; heat, water and CO; hydrology and water management system; land resource management), wood science and technology (biomass conversion; carbonized wood based composites; cellulose; chemical, physical and mechanical properties of wood; timber structure; wood for energy; wood cell formation; wood biochemistry; wood anatomy and plant physiology; wood deteriorating organisms; wood preservation; wooden construction; wood-based material; wood adhesive), wood and urban pest management (insect pest management, ecology and biology of urban pests, control of urban pest including biological, cultural, mechanical, physical and chemical controls), and forest science (biodiversity and society; biodiversity in tropical plantation forests; climate change and biodiversity; forest biomass dynamics; forest carbon accounting and monitoring; forest fire; invasive species; intensive silviculture; structure, growth and function; tree biotechnology). The technical program consisted of 38 oral presentations under 11 sessions and 19 poster presentations.

This publication is a compilation of presented papers. Every effort has been carried out to retain the original meaning and views of authors during the editing processes. All claims on trade products and processes and views expressed do not necessarily imply endorsement by the editors.

We believe that this publication will be a useful source of information and achieved its primary objective of disseminating new experiences and information to researchers, academics, policy makers and students.

The organization of this international gathering and compilation of the proceedings could not have been achieved without the combined effort of all members of the organizing committee and the supports of Research Institute for Sustainable Humanosphere (RISH), Center for South East Asian Studies (CSEAS) Kyoto University, International Center for Interdisciplinary and Advanced Research (ICIAR) – LIPI, University of Bengkulu (UNIB). The editors hereby wish to acknowledge the contributions of all parties.

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DIALLEL ANALYSIS OF BEGOMOVIRUS RESISTANCE AND AGRONOMIC PERFORMANCES IN CHILI PEPPER

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Abstract

Diallel analysis provides estimation of genetic parameters which is important in plant breeding program. This analysis can estimate gene action, combining ability and heterosis of a crossing combination. Objective of this study was to estimate the genetic paramaters of Begomovirus resistance and other agronomic characters in chili pepper using diallel analysis. As much as 42 hybrids and 7 selfed families generated from a full diallel cross of seven parental lines varying in Begomovirus resistance and yield potential were allotted in a randomized complete block design with three replications. Virus infection was made by inoculating 'Segunung' isolate from infected plant using *Bemisia tabaci* as the vector. Based on general combining ability (GCA) value, IPBC12 and IPBC10 showed as good combiners for the resistance, whereas IPBC14 was a good combiner for fruit yield per plant. Considering the value of specific combining ability (SCA), crosses of IPBC18xIPBC26, IPBC10xIPBC15 showed good crossing combinations for Begomovirus resistance and fruit yield, IPBC14x35C2 was a good combination for Begomovirus resistance, whereas IPBC14xIPBC18 was a good combination for fruit yield.

Keywords: Genetic parameters, Begomovirus, *Bemisia tabaci,* diallel analysis

Introduction

Genetic study plays an important role in developing on disease resistant crop variety. It helps elucidate the genetic mechanisms controlling the resistance to permit determining selection strategy during the breeding process [1]. Amongst the methods, diallel analysis is most commonly used to estimate the genetic parameters. This method was developed to explore the genetic behavior of quantitative traits in early generations [2] and to determine superior parents for developing hybrids with desirable performances [3].

Different approaches of diallel analysis have been devised for different purposes of genetic parameter estimation, notably those developed by [4] and [5]. Griffing's diallel is mainly developed through partition of genotypic variance components into general combining ability (GCA) and specific combining ability (SCA) components which, in turn, can be translated into genetic components, including variance to additive genetic variance, dominance variance, and heritability [6]. Knowledge of GCA and SCA estimates from a diallel cross would help the breeder in determining potential parents for creating the best hybrid combinations [7].

Yellow leaf curl caused Begomovirus is a devastative disease in a wide range of important crops causing significant yield losses [8]. In chili pepper, developing resistant varieties would be a reasonable option in easing the risk of failure in the fruit production. However, breeding for disease resistant is a complex process [9]. Several issues may decelerate the breeding process, including the genetic background controlling the resistance and determination of parental materials which generate recombinants having sufficient resistance and high yielding capacities. The objectives of present study were to estimate GCA effect and SCA effect on Begomovirus resistance and chili pepper yield relating traits for determination of potential parents in the development of new high yielding and Begomovirus resistant chili pepper varieties.

Material and Method

Study was conducted during Juli 2008 and April 2009 at screenhouse of Agriculture Production Department, University of Bengkulu and Cikabayan greenhouse and breeding orchard of Bogor Agricultural University. The parental materials used to generate F1, reciprocal, and selfed progenies through a full diallel cross were IPBC10, IPBC12, IPBC14, IPBC15, IPBC18, IPBC26 and 35C2. These parental lines were chosen on the basis of their Begomovirus resistance and agronomic performances.

Seedlings for each genotype was prepared by germinating the seeds on plastic tray containing media consisted of mixture of 1/2 soil, 1/4 compost, and 1/4 rice hull and maintained for 14 days. The resulted seedlings were, then, transplanted on 35 cm x 40 cm polybag containing mixture of 6 kg soil and 0,5 cow manure. The standard recommendations for chili pepper production were adopted in the study.

At 16 days after transplanting, each plant was individually covered with insect-proof cage. About 10 adult whitefly (*Bemisia tabaci*) which had had acquisition access period for 24 h on plants inoculated with Begomovirus carrying isolate 'Segunung' were placed in each caged plant for an additional 48 h. The infected plants were then sprayed with detergent solution and grown in a greenhouse in a randomized complete block design arrangement with three replications. Ten infected plants from each genotype were treated as the experimental plot.

Observations were made on disease intensity (%, measured at first harvest using equation as described by [10 and 11], where disease intesity 0 - 1 %= highly resistant, 1 – 5 % = resistant, 5 – 10 % = moderately resistant, 10 – 20 % = moderately susceptible, 20 – 40 % = susceptible, >40 % = highly susceptible); incubation period (number of days from infection to symptom appearance); plant height and first branch height (cm, measured at first harvest); days to first flowering (number of days from transplanting to first flowering); fruit diameter (mm, mean diameter of 10 fruits per plant); fruit length (cm, mean length of 10 fruits per plant); fruit number (number of fruits per plant from all harvest); and fruit yield per plant (g, total fruit weight per plant).

Analysis of variance was conducted on mean value of cross observed in each block. Diallel analysis was performed according to Grifing's approach considering method I with random model as described by [12]. All analyses were carried out by using statistical software SAS 9.1.

Results and Discusion

Analysis of variance (ANOVA)

ANOVA for Begomovirus resistance and agronomic traits (not shown) indicated significant variations among the genotypes studied. Similarly, ANOVA for combining ability showed that variations due to GCA, SCA, and reciprocal effects were significant on all Begomovirus resistance traits and most of agronomic traits (**Table 1**). These findings suggested that additive and non-additive gene actions [13;14] and maternal effect [15;16] had important influences on the expression of observed traits. Non- significant GCA and reciprocal effects on plant height indicated that this trait was solely controlled by additive gen action. On the other hand, non-significant SCA effect on fruit number and fruit weight indicated that additive gene action was not involved in controlling these traits.

Table 1. Mean square of GCA, SCA, and reciprocal components for Begomovirus resistance and agronomic traits

Source of variation	GCA	SCA	Reciprocal
Disease intensity	803.66 **	89.91 **	125.51 **
Incubation period	183.82 **	114.62 **	102.09 **
Plant height	362.92 ns	347.34 *	210.16 ns
First branch height	390.70 **	30.64 **	32.95 **
Days to first flowering	126.50 **	46.66 *	66.32 **
Fruit diameter	621.04 **	1.04 **	0.84 **
Fruit length	0.27 **	0.01**	0.005 **
Fruit number	1908.13 **	118.39 ns	437.33 **

Fruit yield per plant	1788.04 **	907.24 ns	4920.84 **

* P<0.05, ** P<0.01 respectively

General combining ability (GCA) effect

The significant GCA components shown in **Table 1** also indicated the existence of parental line(s) that, on average, combined well with the other parental lines for the corresponding traits [17]. The evaluation of GCA effects for each pair of cross in **Table 2** suggested that there was no single parental line representing as a good general combiner for all observed traits. The negative sign of a GCA effect on disease intensity and days to first flowering indicated Begomovirus resistant and early flowering, respectively. IPBC12 exhibited a good general combiner for improving Begomovirus resistance, but not for improving fruit number and fruit weight. IPBC10 was the next good general combiner for improving the disease resistance and also served as a good general combiner for improving fruit number, but with small fruit size IPBC10 was not a good general combiner for improving fruit weight. IPBC26 was a good general combiner for minimizing disease resistance, but not good for improving fruit number and fruit weight. IPBC14 was not the best general combiner for disease resistance, but it showed as a maximum GCA effects on improving fruit number and fruit weight, indicating the best general combiner for yield improvement.

Table 2. GCA effects of six chili lines for Begomovirus resistance and agronomic traits

Traits	IPBC10	IPBC12	IPBC14	IPBC15	IPBC18	IPBC26	35C2
Disease intensity	-4.93	-9.93	-4.72	1.93	-0.86	-6.72	7.51
Incubation period	0.09	-2.87	2.70	-3.44	0.62	-2.53	-1.65
Plant height	5.11	-5.44	0.27	-1.23	-3.49	-4.33	3.06
First branch height	4.39	7.19	-0.49	-2.78	0.88	-0.23	2.55
Days to first flowering	5.13	0.55	6.47	2.39	-0.01	1.77	2.92
Fruit length	-1.87	-1.44	-0.06	-0.53	-0.09	-1.11	-0.76
Fruit diameter	-0.23	-0.18	-0.04	-0.03	-0.06	-0.05	-0.17
Fruit number	13.05	-6.67	18.22	-4.22	-5.68	-5.16	-3.61
Fruit yield per plant	-11.67	-40.91	61.68	-19.32	-17.89	-24.87	-26.96

Specific combining ability (SCA) effect

SCA effects of the crosses are presented in **Table 3**. It shows that there were a number good crosses with desirable magnitude and direction for Begomovirus resistant and agronomic performances. IPBC18 x IPBC26 exhibited a maximum negative SCA effects on disease intensity and incubation period, implying the most resistant hybrid to Begomovirus. Furthermore, this hybrid had considerable SCA effects on fruit number and fruit yield per plant. IPBC10 x IPBC15 conferred a relatively resistant hybrid to the virus and produced early flowering plant and high yield due to high negative SCA effect on days to flowering and high SCA effect on fruit yield per plant. IPBC14 x 35C2 was less resistant hybrid to Begomovirus, but it had a considerable positive SCA effect on fruit number and fruit yield per plant. Although IPBC10 x 35C2 was the second best Begomovirus resistant hybrid, it less desirable due to large negative effects on fruit number and fruit yield per plant. Similarly, IPBC14 x IPBC18 showed the maximum SCA effect on fruit yield per plant but it was relatively susceptible to Begomovirus. As [4] has pointed out that selecting for the hybrids with high specific SCA effect from at least one parent with high or average GCA effects for a desired trait is a sensible strategy for plant breeding. Considering the situation, IPBC18 x IPBC26 and IPBC10 x IPBC15 were considered the best combinations for Begomovirus resistance, days to first flowering, and fruit yield per plant, although GCA effects of the corresponding parental lines were trivial on fruit yield per plant.

Conclusion

1. IPBC12 and IPBC10 were good combiners for the resistance, whereas IPBC14 was a good combiner for fruit yield per plant.
2. Hybrid IPBC18xIPBC26, IPBC10xIPBC15 conferred good crossing combinations for Begomovirus resistance and fruit yield,
3. HybridIPBC14x35C2 was a good combination for Begomovirus resistance.
4. IPBC14xIPBC18 was a good combination for fruit yield

Tabel 3 SCA effects of crosses for Begomovirus resistance and agronomic traits

Crosses	Disease intensity	Incubation period	Plant height	First branch height	Days to first flowering	Fruit length	Fruit diameter	Fruit number	Fruit yield per plant
IPBC10 x IPBC12	0.36	-1.95	7.00	3.04	-2.54	0.61	0.02	0.57	8.72
IPBC10 x IPBC14	-0.07	4.04	8.48	8.97	0.36	-0.51	-0.01	20.99	-1.56
IPBC10 x IPBC15	-6.00	-1.94	14.90	0.30	-12.51	1.08	0.03	-1.51	16.79
IPBC10 x IPBC18	4.43	-0.65	-8.66	0.98	-0.27	-0.34	-0.03	-8.38	-4.20
IPBC10 x IPBC26	7.93	3.23	-0.97	-6.30	1.01	-0.01	0.02	2.13	17.90
IPBC10 x 35C2	-8.86	-5.77	-1.59	-5.43	4.89	-0.55	-0.02	-2.73	-11.01
IPBC12 x IPBC14	-1.42	-2.18	-10.63	-1.29	2.58	-0.63	-0.04	3.82	2.42
IPBC12 x IPBC15	-0.84	-4.20	-4.26	-2.35	3.15	0.21	-0.05	-0.85	0.62
IPBC12 x IPBC18	2.58	-2.41	-7.60	-4.17	-5.05	0.11	0.01	2.08	7.50
IPBC12 x IPBC26	-3.42	-8.42	15.71	-0.75	0.60	-0.31	-0.08	-6.76	-13.53
IPBC12 x 35C2	-2.78	21.00	-11.79	-2.07	-0.80	-0.06	0.03	7.89	1.80
IPBC14 x IPBC15	-5.27	-0.74	-10.63	-1.73	7.27	-0.22	0.03	-7.21	-31.11
IPBC14 x IPBC18	3.16	-1.29	9.92	2.38	2.42	0.56	0.04	-2.66	44.81
IPBC14 x IPBC26	6.66	10.53	3.08	0.35	-4.70	1.54	0.01	-9.53	-29.40
IPBC14 x 35C2	-0.71	-8.17	8.47	1.50	3.77	1.01	0.03	5.89	40.54
IPBC15 x IPBC18	11.73	-0.92	-6.29	-2.09	3.55	-0.31	-0.04	0.33	-20.95
IPBC15 x IPBC26	2.73	0.63	-29.12	2.94	0.12	-0.85	-0.11	4.72	13.70
IPBC15 x 35C2	0.86	-1.97	5.68	-0.67	-3.51	0.47	0.05	-2.59	-6.50
IPBC18 x IPBC26	-15.84	-11.68	18.91	2.62	0.34	0.79	0.13	8.25	12.63
IPBC18 x 35C2	2.29	-2.85	-1.98	0.12	-0.35	-0.01	-0.01	-2.93	-16.01
IPBC26 x 35C2	11.29	-0.11	-14.11	2.27	2.48	-0.13	-0.13	4.15	13.13

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