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EVALUATION OF GROWTH AND YIELD PERFORMANCE ON INOCULATED CHILI PEPPER HYBRIDS BY CUCUMBER MOSAIC VIRUS

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ABSTRACT

Tolerance cultivar is a best control measure to reduce losses due to virus attack in the field. Study on growth and yield of new cultivars compared to the commercial ones is an important step in cultivar development. The objective of this research was to evaluate growth and yield performance of inoculated new chilli pepper hybrids by Cucumber Mosaic Virus (CMV) compared to a commercial and similar fruit size one. Twelve new hybrids and one commercial hybrid cultivar 'Prada', as a control, were evaluated in a completely randomized design with 3 replications. In the greenhouse experiment, H23 and H20 showed better vegetative growth compared to the other hybrids and control. Hybrid H17 showed the highest yield, followed by H5, H4 and H6 hybrids.

Keywords: chili pepper hybrids, CMV, growth, yield

INTRODUCTION

National chilli pepper production is still inferior to their increasing demand leading to high amount of import of this commodity. In 2010, the import value was US$ 17.274 million (BPS, 2011), and it increased by 50% in the following years (BPS, 2012). This situation is on account of low chilli pepper productivity in the field. The average chilli pepper production was about 6.3 ton ha^{-1} (BPS, 2007). It is far below the average of capsicum production of other countries, such as China (14.4 ton ha^{-1}) or Spain (31.1 ton ha^{-1}) (Rubatzky and Yamaguchi, 1997).

Low chilli pepper production level in the field is attributable to many factors, primarily genetically low yield potent of chilli pepper cultivars grown by the farmers and virus attack causing the plants to be unable to reach their maximum yield. The most strategic approach to overcome the problem is to develop high-yielding hybrid cultivars tolerant to most important diseases, one of which is cucumber mosaic virus (CMV).

Hybrid cultivar development is commonly conducted based on heterosis phenomena when a pair of parental line is crossed. Heterosis potential is the superiority of the offspring compared to the average or the higher parent (Fehr, 1987). In chilli pepper hybrid selection, Patel *et al.* (2010) mainly elaborate the heterosis potential observed on the parental cross. Heterosis was also used as the main consideration in the development of many other hybrid cultivars, such as rice hybrids for drought tolerance (Muthuramu *et al.*, 2010), momordica hybrids for fruit yield and quality (Thangamani *et al.,* 2011).

The use of hybrid cultivars have proven to increase yield significantly in many crops compared to traditional cultivars commonly grown by farmers. Hybrid cultivars, therefore, is the main objective of modern breeding programs in developing new chilli pepper cultivars due to their yield superiority compared to line type cultivars (Crosby, 2008).

A set of research project has been previously conducted to develop chilli pepper hybrids tolerant to CMV, and a number of hybrids are in need of further evaluation. This part of the research was aimed to evaluate growth and yield performance of inoculated new chilli pepper hybrids by CMV compared to the those of commercial one.

MATERIALS AND METHODS

An experiment was conducted in the green house of Department of Agronomy,

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Faculty of Agriculture, University of Bengkulu at elevation of 15 m above sea level, from April to September 2013. The genetic materials involved 13 new hybrids developed for CMV tolerance, i.e. H2, H4, H5, H6, H8, H11, H13, H14, H17, H19, H20, H22, H23, and a commercial hybrid cultivar, 'Prada'. The experiment was arranged in a completely randomized design with 14 hybrids as the treatments and 3 replications. Each experimental unit consisted of 2 plants grown in plastic bag with 10 kg planting media.

Seeds were sown on 72 celled plastic trays with soil-manure mix of 1:2 (v/v). At the cotyledon stage, all seedlings were manually inoculated with CMV 02 inoculums of LEHRI Bandung. Re-inoculation was done at first true leaf stage. At 5 weeks after sowing, the seedlings were transplanted into plastic bags with 10 kg top soil media mixed with 10% manure, equivalent to 20 ton ha^{-1}. A few number of carbofuran granules were used as a preventive control for soil born pest. A mix of urea, SP36 and KCl equivalent to 100, 200 and 100 kg ha^{-1}, respectively, was used as starter fertilizer, applied prior to transplanting. Supplement fertilizer of urea equal to 100 kg ha^{-1} was supplied at 6 weeks after transplanting.

Plant maintenance included watering, staking, lateral shoot pruning and pest controlling. Watering up to a field capacity was carried out every morning. Staking the plant to prevent lodging was done by bamboo stakes of 75 cm length and 4 cm width. All lateral and below dichotomous shoots were cut off manually. Pest and disease control was done every week with a mix of profenophos insecticide and mankozeb fungicide of 2 ml l^{-1} and 2 g l^{-1}, respectively. Mature fruits, indicated by at least 75% of a fruit have shown red color, were harvested periodically, every 5 days.

Vegetative growth, i.e. plant height, first dichotomous height, stem diameter, number of branches, and canopy diameter, was measured at the end of the experiment. Yield component, i.e. number of fruit set, fruit length, fruit diameter, were measured at harvesting time. Analysis of variance was applied on all data collected followed by Duncan's Multiple Range Test (DMRT) at 5%, following the method of Steel and Torrie (1981).

RESULTS AND DISCUSSION

Vegetative growth observed based on plant height, stem diameter, number of branches, dichotomous height and canopy diameter showed varied performance among hybrids. Hybrid H20 showed the highest plant height, followed by H23, while H22, H14 and Prada were the lowest ones. Hybrid H23 and H13 revealed sturdy growth with the highest stem diameter, whereas H22 and Prada were the thinnest ones. In term of the number of branches, hybrid H23, followed by H20, possessed higher number of branches compared to other hybrids, while 'Prada' had the fewest number of branches. Hybrid H23 and H2 showed the biggest canopy diameter, and H19 had the smallest one (Table 1). Overall, hybrid H23, followed by H20, showed the best vegetative performance indicated by vigorous shoot growth among tested hybrids. Conversely, the control, 'Prada' showed weaker shoot growth compared to some new developed hybrids.

Variability among hybrids was also noticed from their yield components. Hybrid H17 showed the highest number of fruit, in contrast, 'Prada' produced a fewer number of fruits than other hybrids. Hybrid H17 and H5 also revealed the highest fruit weight, followed by H5, H4, H6, H14, H23 and H20. Total fruit weight of those hybrids was also higher than that of 'Prada' and the other hybrids.

Hybrids H5 and H6 had relatively longer shape of fruits than the others. The biggest fruit diameter was shown by H14 and H6 (Table 2). Most of these newly developed hybrids had the fruit diameter relatively similar to control. Based on those yield and yield component traits, especially fruit weight and number of fruits, hybrids H17, H5, H4, H6, H14, H23 and H20 were the most promising hybrids in this preliminary evaluation. All of them exhibited total fruit weight per plant significantly higher compared to the control, 'Prada'.

Table 1.Growth performance of newly developed chilli pepper hybrids

Hybrids	Plant height (cm)	Stem diameter (mm)	Canopy diameter (cm)	Dichotomous height (cm)	Number of branches
H2	77.7 ab	7.0 ab	73.8 b	44.0 ab	249 ab
H4	82.0 ab	8.0 ab	64.2 ab	38.3 ab	121 ab
H5	80.7 ab	7.1 ab	56.5 ab	37.7 ab	188 ab
H6	85.7 ab	6.5 ab	53.7 ab	45.7 ab	135 ab
H8	76.3 ab	6.6 ab	49.2 ab	33.3 a	147 ab
H11	76.7 ab	7.4 ab	69.7 ab	40.3 ab	165 ab
H13	92.0 ab	8.2 b	63.2 ab	38.3 ab	160 ab
H14	75.0 a	6.4 ab	56.7 ab	40.7 ab	191 ab
H17	81.0 ab	8.0 ab	68.8 ab	34.7 a	201 ab
H19	88.7 ab	7.4 ab	51.3 ab	39.7 ab	185 ab
H20	106.0 b	8.0 ab	61.7 ab	42.3 ab	253 ab
H22	71.7 a	5.4 a	35.3 a	39.3 ab	211 ab
H23	96.0 ab	8.3 b	77.8 b	49.7 b	271 b
PRD	76.3 ab	5.7 ab	40.8 ab	44.0 ab	87 a

Remarks: Numbers in the same column followed by the same letter were not significantly different based on DMRT 5%

Tabel 2. Yield compent and yield performance of newly developed chilli pepper hybrids

Hybrids	Number of fruit	Fruit weight (g)	Fruit length (cm)	Fruit diameter (mm)
H2	81.3 f	271.5 a	7.5 a	11.3 a-c
H4	64.7 de	510.2 c	12.3 bc	12.7 a-d
H5	59.3 c-e	605.2 d	14.6 d	13.3 a-d
H6	66.7 e	507.7 c	13.9 cd	16.0 de
H8	51.7 bc	345.3 ab	12.4 bc	11.5 a-c
H11	44.0 b	368.9 b	12.1 bc	14.7 c-e
H13	52.3 bc	382.5 b	11.1 b	13.6 a-d
H14	43.3 b	496.1 c	11.3 b	17.6 e
H17	86.7 f	623.3 d	10.9 b	10.1 a
H19	55.7 cd	374.7 b	11.1 b	13.4 a-d
H20	53.3 c	463.8 c	12.4 bc	14.3 b-e
H22	43.7 b	369.9 b	12.1 bc	10.6 ab
H23	60.3 c-e	467.0 c	12.6 bc	13.9 a-e
PRD	31.7 a	380.4 b	11.8 b	13.7 a-e

Remarks: Numbers in the same column followed by the same letter were not significantly different based on DMRT 5%

In this study, it was noticeable that the better the vegetative performances of the plants, which were indicated by higher plant height, dichotomous height, stem diameter, canopy diameter and number of branches, inconsequentially the higher the yield. There was variability among hybrids in term of growth-yield relationship. Of certain hybrid such as H23, relatively high yield was in line with high vegetative growth. Conversely, of hybrid H17 or H5, their superior yield was not in accordance with their medium growth performance. Therefore, generally, the relationship between vegetative growth and yield was low, even though the measured variables were plant biomass component (Vieira *et al.* 2009). Total biomass, up to certain level, commonly represents plant source strength to produce photosynthetic materials. Almost similar phenomenon was observed in Gopinath *et al.* (2009). This is probably due to variation of effectiveness of sink-source relationship among hybrid genotypes. The result was not in line with that of Wubs *et al.* (2009) and Di'az-Pe'rez (2010), emphasizing that vegetative growth is always in harmony with the yield. Effectiveness of sink-source relationship is

possibly influenced by genetic and environmental factors. Differences in genetic materials used along with micro-environmental manipulation given to the plants will reveal different source-sink relationship pattern.

Hybrids exhibiting high yield are probably related to their fruit length and total number of fruit set. Those yield components prominently determine plant yield. This result was in agreement with Wubs *et al.*, (2009) and Shongwea *et al.,* (2010) stating that the genotype possessing longer fruits tends to yield higher. Fruit length determines individual fruit weight. The other important factor determining plant yield is the total number of fruit set. Relatively high yield of H17 and H5 are closely related to their high fruit set. This is in harmony with the result of Wubs *et al.* (2009); Shongwea *et al.* (2010); and Alsadon *et al.* (2013).

Although its vegetative performance, yield component and yield were not superior to most of newly developed hybrids, the commercial hybrid 'Prada' was visually more attractive in term of fruit shape, texture and coloration. This hybrid is the end product of advanced breeding programs which is not only directed toward high yielding but also high fruit quality. Some newly developed hybrids in this research are potential for further fruit quality improvement besides their high yield.

CONCLUSION

Hybrids H23 and H20 performed strong vegetative growth. H17, H5, H4 and H6 having higher yield are promising for further evaluation to develop high fruit yield and quality chilli pepper hybrids.

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