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Genetics of yield and its components in eggplant (*Solanum melongena* L.)

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Abstract
Inheritance study for yield and its components were conducted in five selected parents of brinjal namely MTE 1, MTE 2, Terung Bujur, Terung Telunjuk and NTH080077. Parents, F_1 and F_2 progenies were evaluated under field condition at MARDI, Serdang. Data on vegetative and yield components were recorded for parents F_1 and F_2 populations. Genetics study for inheritance were evaluated, and it showed that days to flower, fruit number per plant and fruit weight were observed as additive gene effect. Whereas, plant height and yield per plant were dominance gene effect. High heritability and high genetic advance were observed for fruit number per plant, fruit weight and yield per plant. Low and moderate phenotypic and coefficient of variations were observed for all traits. Moderate phenotypic and coefficient of variations were expressed by fruit number per plant, fruit weight and yield per plant. The selection of genotypes with high heritability coupled with genetic advance for these traits indicates the potential for crop improvement through selection.

Key words: *Solanum melongena*, inheritance, yield and its components, eggplant

Introduction

Solanum melongena L. (eggplant) is a common and important vegetable in many Asian countries. It is highly productive crop and consumed as cooked vegetable in various ways, and has high nutritional value similar to tomato (Choudhury 1972). *Solanum* belongs to the family Solanaceae, one of the largest families containing a large number of economic crops for their edible leaves or fruits. According to FAOSTAT (2008), the world eggplant production areas were 2,043,788 ha in 2007. Total production of eggplant in Malaysia increased from 22.637 tonnes to 23.290 tonnes in 2005 to 2010 (Anon. 2010). The production areas of eggplant in Malaysia are very low as compared to other countries, but the demand for eggplant is still increasing.

As a developing country, Malaysia needs continuous research intensively on vegetable crops including eggplant. It produces only a quarter of what the industry requires. In other words, supply fails to satisfy demand, and so the Malaysian market has become dependent on imports of fresh vegetables from abroad. Meanwhile, information on inheritance is important in eggplant, especially for crop improvement. It is well known that through information

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on inheritance, a character to be examined is of great importance in selection practice. For selection, it is necessary to find out first to what extent the phenotypic variations of the characters in segregating generations are under genes control (Allard 1960). This study was initiated to examine the yield traits, their inheritance through crosses of selected parents and their impact on high yielding eggplant varieties. The information about inheritance can be used as a basis for selection of desirable traits in eggplant such as resistance or tolerance to diseases, fruit quality and high yield. In order to develop varieties with good agronomic characters, acceptable fruit yield and sizes were selected based on single seed descent with progeny row testing and selection must be used since backcrosses is not suitable for fixing such traits (Adams and Osei 2006).

Materials and methods

The study was conducted at MARDI's experimental plot, Serdang in 2010 and 2011. Five selected varieties MTE 1, MTE 2, Terung Bujur (T. Bujur), Terung Telunjuk (T. Telunjuk) and NTH080077 were used as parents. MTE 1 and MTE 2 were MARDI's commercial varieties with acceptable fruit yield and characterised as long (MTE 1) and round (MTE 2) fruit shape with purple skin colour. T. Bujur is also a commercial eggplant with good yield, oblong fruit shape and purple skin colour. However, T. Telunjuk and NTH080077 are local eggplant varieties with small size, long and round fruit shape, and green and light purple skin colour respectively, low yield and commonly used as salad or 'ulam'. Random crosses without reciprocal were carried out and only three F_1 hybrids seed were obtained (MTE 2 x MTE 1, MTE 2 x NTH080077 and T. Bujur x T. Telunjuk). Hybrid seeds were grown and selfed in glasshouse for production of F_2. The parents and F_1 and F_2 were grown using experimental design of randomised complete block design (RCBD) with three replicates. The parents and F_1 consist of 10 plants per replicate while F_2 consist of 90 plants per replicates. One-month-old seedlings were transplanted with planting distance of 0.6 m within rows and 0.8 m between rows.

The field irrigated two times during the growing season from August 2010 – February 2011. Other cultural practices were followed normally (MARDI 1992). Analysis of variance (ANOVA) and Duncan multiple range were used to distinguish the plant means (SAS Inst. 1990). The genetic parameters like heritability, genetic advance, phenotypic and genotypic coefficient of variation were calculated for all five characters according to Comstock and Robinson (1952), Johnson et al. (1955) and Allard (1960).

Results and discussion

Analysis of variance showed that all genotypes were significantly different (p <0.01) for yield and its components (*Table 1*). This indicated that the genotypes were significantly different from each other in terms of days to flower, plant height, fruits number per plant, fruit weight and yield per plant. Coefficient of variation (CV) values for yield and its components ranging from 5.23 – 18.61% showed that less variability occur for all traits.

Days to flower

The variety NTH080077 was significantly early flowering (49.83 ± 0.32) compared to MTE 2 and T. Telunjuk, and showed no differences with MTE 1 and T. Bujur. Where as, T. Telunjuk was late flowering (60.37 ± 0.76) and highly significant with NTH080077. The F_1 (T. Bujur x T. Telunjuk) showed early flowering (49.93 ± 2.22) and F_1 (MTE 2 X MTE 1) showed latest flowering with 58.33 ± 2.52 (*Table 2*). Overall, F_1 population reached the days to flower at the same time as parents. This finding contrast with Saha et al. (1993) that hybridisation using Uttara (early flowering eggplant variety) and Islampuri (late flowering eggplant variety) showed dominance for earliness over lateness. In

Table 1. Mean squares from ANOVA and coefficient of variation (CV) for yield and its component in eggplant genotypes

Source	df	Yield and components				
		Days to flower	Plant height (cm)	Fruit number/plant	Fruit weight (g)	Yield/plant (g)
Treatment	12	35.95**	76.44**	189.43**	4439.33**	813800.92**
Error	20	8.27	12.21	13.39	152.38	29636.91
Total	32					
CV		5.23	10.23	18.61	15.04	13.00
Mean		54.95	34.15	19.65	82.05	1323.86

**Significantly different at $p < 0.01$

all crosses of F_2 means gave no differences between parents and F_1 population. The frequency distribution of F_2 population in all crosses showed a wide variation for days to flower having some transgressive segregation towards lateness (*Figure 1a, 2a* and *3a*). Moderate heritability (56.23%) along with considerable amount of genetic advance (9.17%) revealed that limited number of genes is involved for the control of this character (*Table 3*). Similar findings also reported by Sidhu et al. (1980) and Saha et al. (1993). However, Peter and Singh (1973, 1976) and Hani et al. (1977) found over dominance gene effect for days to flower in eggplant. The lowest phenotypic coefficient of variation (5.93%) and genotypic coefficient of variation (7.92%), which were in conformity with the findings of Saha et al. (1993), indicate less environment influence upon the genetic expression of this trait.

Plant height

MTE 1 was the taller plant (36.87 ± 1.75 cm) while NTH080077 was the lowest plant (28.03 ± 0.43 cm). The F_1 of MTE 2 x MTE 1 and T. Bujur x T. Telunjuk was higher than parents, except MTE 2 x NTH080077 was no difference between parents (*Table 2*). This finding indicates the presence of heterosis and dominance gene controls this trait, which is tallness over dwarfness (Choudhuri 1972). F_2 population showed no difference with parents and F_1 (*Table 2*) and having little shift towards tallness especially in F_2 (T. Bujur x T. Telunjuk) which showed trangressive segregation towards tallness traits. The F_2 frequency distribution was unimodal (*Figure 1b, 2b* and *2c*) suggesting polygenic control of the plant height. Moderate heritability (66.74%) and genetic advance (24.40%) were observed for plant height and this finding support the polygenic nature for this trait, as observed by Saha et al. (1993). Low genotypic (14.50%) and phenotypic coefficient of variation (17.75%) were considerably low genetic variability and more influence of environment (*Table 3*).

Fruit numbers per plant

Fruit numbers per plant is one of the factors which directly determine the yield. T. Telunjuk recorded the highest mean number of fruits per plant (34.50 ± 2.57) and the lowest was MTE 2 (15.17 ± 0.47) (*Table 2*). In all crosses, the parents were significantly different from F_1s except for MTE 2 x MTE 1. In F_1 population (MTE 2 X NTH08077) for fruit number showed additive gene effect (*Table 2*). Similar findings also reported by Singh et al. (1994), Manju and Sreelathakumary (2002). The F_2 population showed wide variation with mean of 6.73 ± 0.37 (MTE 2 x MTE 1), 13.47 ± 1.80 (MTE 2 x NTH080077) and 11.73 ± 0.47 (T. Bujur x T. Telunjuk). Transgressive segregation for fruit number per plant was observed (*Figure 1c, 2c* and *3c*). High heritability (84.08%) coupled with high genetic advance (80.83%) and moderate phenotypic (46.67%) and genotypic coefficient of variation (42.79%)

Table 2. Mean (±SE) for yield and its components in eggplant genotypes

Genotype	Days to flower	Plant height (cm)	Fruit no./plant	Fruit weight (g)	Yield/plant (g)
MTE 1	55.13a-d ± 2.13	36.87bc ± 1.75	19.80bc ± 1.05	96.20cd ± 2.50	1912.70ab ± 48.68
MTE 2	56.30abc ± 1.30	31.47cde ± 3.10	15.17cd ± 0.47	123.97b ± 5.93	1880.70ab ± 127.99
T. Bujur	52.00cd ± 0.67	30.43cde ± 0.73	17.17cd ± 0.72	119.37b ± 2.02	2044.60a ± 124.83
T. Telunjuk	60.37a ± 0.76	30.10de ± 0.81	34.50a ± 2.57	17.37f ± 0.23	596.60e ± 37.13
NTH080077	49.83d ± 0.32	28.03e ± 0.43	32.60a ± 5.30	21.53f ± 1.68	684.50e ± 68.47
F_1 (MTE 2X MTE 1)	58.33ab ± 2.52	39.33ab ± 3.68	15.60cd ± 1.76	108.10bc ± 4.96	1705.60b ± 276.94
F_1 (MTE 2 XNTH08077)	54.03bcd ± 0.52	27.70e ± 1.73	25.57b ± 2.10	72.87e ± 5.15	1828.80ab ± 51.33
F_1 (T. Bujur X T. Telunjuk)	49.93d ± 2.22	43.8a ± 4.23	23.90b ± 0.06	55.77e ± 1.04	1308.60c ± 21.75
F_2 (MTE 2 X MTE 1)	53.77bcd ± 2.77	32.53cde ± 0.67	6.73e ± 0.37	148.83a ± 19.42	1051.20cd ± 56.47
F_2 (MTE 2 X NTH080077)	54.50bcd ± 0.47	35.13bcd ± 1.31	13.47cd ± 1.80	78.47de ± 9.64	840.20de ± 45.56
F_2 (T. Bujur X T. Telunjuk)	60.33a ± 2.38	40.33ab ± 0.13	11.73de ± 0.47	60.17e ± 3.88	709.10e ± 16.97

Significantly difference at $p < 0.05$

Table 3. Estimates of genetic parameters for yield and its components in eggplant

Trait	Mean	VG	VP	GCV (%)	PCV (%)	Heritability (%)	GA (%)
Days to flower	54.95	10.65	18.93	5.93	7.92	56.23	9.17
Plant height (cm)	34.15	24.53	36.75	14.50	17.75	66.74	24.40
Fruit number/plant	19.65	70.71	84.10	42.79	46.67	84.08	80.83
Fruit weight (g)	82.06	1709.35	1861.73	50.38	52.58	91.81	99.44
Yield/plant (g)	1323.87	310247.66	339884.57	42.07	44.03	91.28	82.79

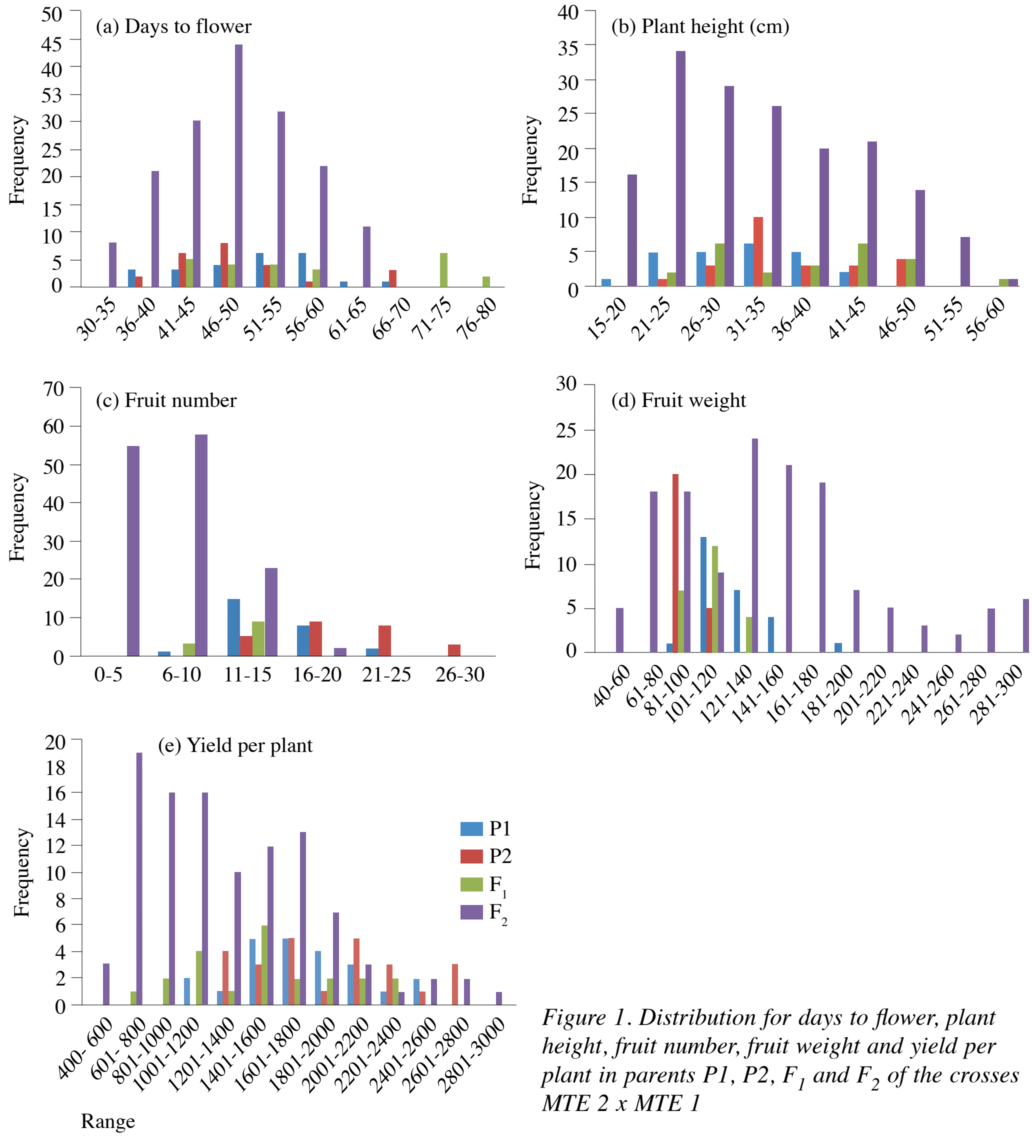


Figure 1. Distribution for days to flower, plant height, fruit number, fruit weight and yield per plant in parents P1, P2, F_1 and F_2 of the crosses MTE 2 x MTE 1

were observed for this trait (*Table 3*). High heritability estimates indicate the presence of large number of fixable additive factors, and hence this trait may be improved by selection (Manju and Sreelathakumary 2002). The phenotypic of variation was near to genotypic coefficient of variation, indicating highly significant effect of genotype on phenotypic expression with little effect of environment, which was in conformity with the findings of Manju and Sreelathakumary (2002).

Fruit weight

Fruit weight is one of the most important traits in eggplant, which determines the total of yield. MTE 2 recorded the highest fruit weight 123.97 ± 5.93 g, and lowest fruit weight was T. Telunjuk 17.37 ± 0.23 g. All crosses showed highly significant between parents and F_1 except for MTE 2 x MTE 1 (*Table 2*). Fruit weight of F_1s were in intermediate between parents and it is governed by additive and dominant genes effect. This finding is similar to

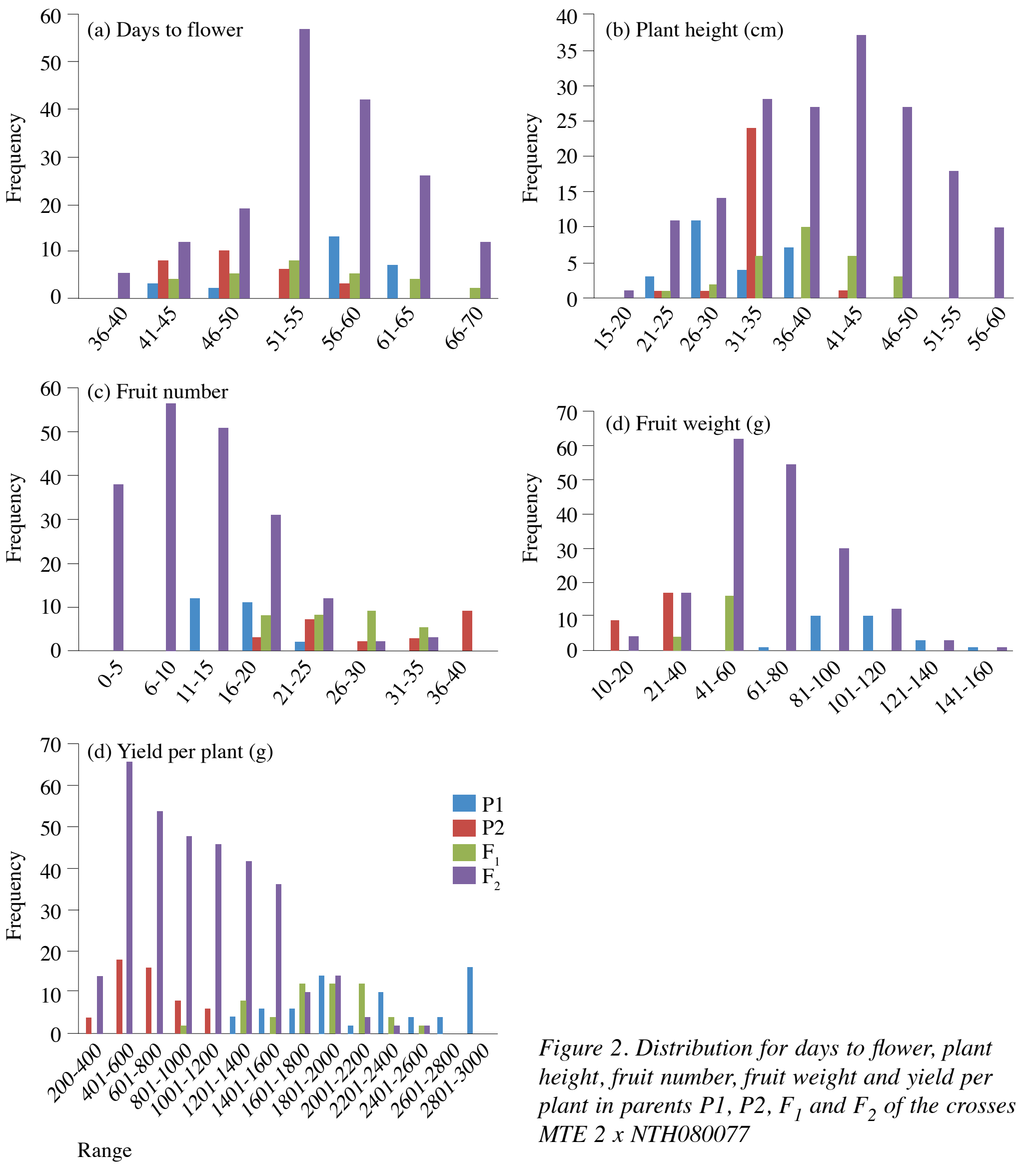
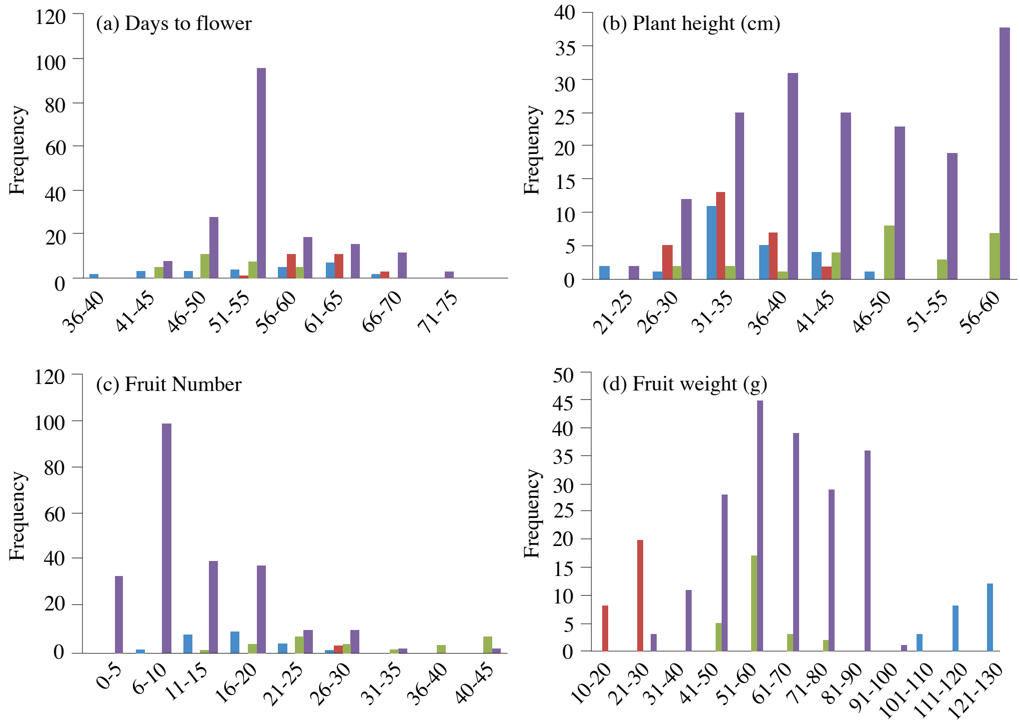


Figure 2. Distribution for days to flower, plant height, fruit number, fruit weight and yield per plant in parents P1, P2, F_1 and F_2 of the crosses MTE 2 x NTH080077

report by Dharme Gowda (1977). It had the main role in inheritance with greater influence of additive component as indicated by Damjanovic et al. (2002). Selecting process for such trait in later generations will be effective (Adam and Osei 2006). F_2 frequency was curve suggesting polygenic inheritance of the traits (*Figure 1d, 2d* and *3d*). High phenotypic (52.58%) and genotypic coefficient of variation (50.38%) were observed for this trait (*Table 3*). Similar results were also reported by Manju and Sreelathakumary (2002). Higher heritability estimates (91.81%) and genetic advance (99.44%), high phenotypic and genotypic coefficient of variation indicated high variability and selection process might be effective for this trait.

Yield per plant

T. Bujur showed the highest yield per plant (2044.60 ± 124.83 g) with highly significant with T. Telunjuk (596.60 ± 37.13 g) which the lowest yield per plant (*Table 1*). All the



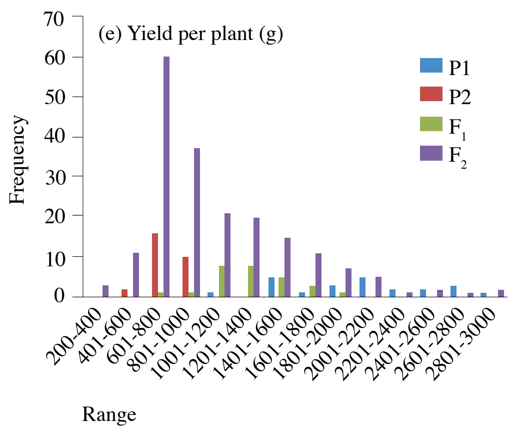


Figure 3: Distribution for days to flower, plant height, fruit number, fruit weight and yield per plant in parents P1, P2, F_1 and F_2 of the crosses T. Bujur x T. Telunjuk

F_1 population was not significantly different with parents except T. Bujur x T. Telunjuk. Yield per plant of F_1 population showed intermediate and more towards the higher parent value suggesting the dominance of high yield over low yield per plant (*Table 2*). A similar finding was reported by Sidhu et al. (1980). However, Dharme Gowda (1977) and Hani et al. (1977) observed as additive and non-additive gene effects. The F_2 population showed wide variation with mean 1051.20 ± 56.47 g (MTE 2 x MTE 1), 840.20d ± 45.56 g (MTE 2 x NTH080077) and 709.10 ± 16.97 g (T. Bujur x T. Telunjuk). Transgressive segregation was observed (*Figure 1e, 2e* and *3e*) which showed that polygenic was controlling the trait. High heritability (91.28%) and genetic advance (82.79%) are advantageous and an indication of additive gene effect and high variation of genetic gain from selection. This confirms the findings of Manju and Sreelathakumary (2002). *Table 3* showed moderate phenotypic (44.03%) and genotypic coefficient of variations (42.07%), which indicates some sort of intermediate influence of environment.

Conclusion

Eventually, it can be concluded that high heritability with high genetic advance indicates the control of additive gene and selection may be effective for those selected traits.

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Abstrak

Kajian kadar kebolehwarisan bagi hasil dan komponen hasil dijalankan ke atas lima induk terung terpilih iaitu MTE 1, MTE 2, T. Bujur, T. Telunjuk dan NTH080077. Induk progeni F_1 dan F_2 dinilaikan di MARDI, Serdang. Data untuk peringkat vegetatif dan komponen hasil direkodkan bagi induk, populasi F_1 dan F_2. Penilaian genetik untuk kadar kebolehwarisan menunjukkan bahawa bilangan hari berbunga, bilangan buah per pokok dan berat buah dipengaruhi oleh tindakan gen menambah. Manakala tinggi pokok dan hasil per pokok pula dipengaruhi oleh tindakan gen dominan. Kadar keterwarisan dan kemajuan genetik yang tinggi dapat dilihat pada bilangan buah per pokok, berat buah dan hasil per pokok. Pekali variasi genotip dan pekali variasi fenotip adalah rendah dan sederhana untuk kesemua ciri hasil dan komponen hasil. Pekali variasi genotip dan pekali variasi fenotip adalah sederhana ditunjuk oleh bilangan buah per pokok, berat buah dan hasil per pokok. Proses pemilihan genotip dengan kadar keterwarisan dan kemajuan genetik yang tinggi untuk hasil dan komponen hasil menunjukkan potensi penambahbaikan tanaman melalui proses pemilihan.