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Mid-parent based Heterosis in diallel crosses of soybean genotypes

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This study aimed to determine the heterosis value in 20 combinations of diallel crosses and find out which breeds of F_1 crosses are superior compared to their parents. The hypothesis of this experiment was that the combination of the diallel crosses of five soybean varieties will provide F_1 genotypes better than the average parent. The experiment was conducted in April 2018, at the State Polytechnic of Jember. The research materials used were five soybean varieties i.e. Dega-1, Gemasugen-1, Gemasugen-2, Sinabung, Gema. The experiment was designed using a Randomized Block Design (RBD) with 25 treatments with 3 replications. The data obtained were analyzed using analysis of variance and if significantly different followed by further testing using the Scott-Knott test with a 95% confidence level. Observation variables included plant height, number of fertile books, number of primary branches per plant, age of flowering, age of ripe harvest, number of filled pods, number of empty pods, weight of 100 seeds, number of seeds per plant, weight of seeds per plant, and seed yield per plant. The best crosses as a whole were produced in the Gamasugen-2 and Dega-1 crosses which showed high heterosis symptoms, especially in plant height parameters, maturity of harvest, number of filled pods, and pod weight per plant.

Keywords: Heterosis, Soybean, Mid Parent , genotypes, of Dega-1, Gemasugen-1, Gemasugen-2

INTRODUCTION

Soybeans are important annual food crops after rice and corn. Soybeans have high protein content which ranges from 30-40%. Soybean seeds also contain vegetable oil by 20%, so soybeans are very well used as food for consumption (Kartasapoetra, 1988). Soybeans are used as raw materials for industries with high economic value. Its use is mostly used as direct feed ingredients or made into various food preparations. Consuming soy is very good for the body because it contains elements and important food substances such as protein, fat, carbohydrates and so on. Besides being used on the seeds, some parts of this plant are also useful, for example from the leaves and stems can be used for animal feed and green manure.

At present the need for soybeans has increased with increasing population, while domestic soybean production has not been able to meet the needs. The current very high and still increasing soybean needs have not been fulfilled by national production, so that import activities from other countries also increase every year (Kasjadi et al., 2000). The total demand for soybeans continues to increase by 2.71 million tons in 2015 and is expected to increase to 3.35 million tons in 2025. (Simatupang et al., 2005). Data from the Ministry of Agriculture said, from 2011-2016 the productivity of soybeans had fluctuated. Year 2011 to 2015 soybean productivity has increased to reach 15.68 kw/ha, but in 2016 soybean productivity has decreased, with productivity results of 14.90 kw/ha or a decrease of 0.78 kw/ha.

According to Suprapto (2001), the low productivity of soybeans in Indonesia is also caused by the fact that farmers still use some local varieties where local varieties have low levels of productivity, are susceptible to pests and diseases, are susceptible to natural changes and are unable to compete with weeds.

Efforts are being made to increase soybean production in Indonesia, some of which are the use of improved varieties. This effort is carried out by the government in this case the Ministry of Agriculture so that the needs of soybeans are fulfilled by implementing technology creation programs and assembling superior varieties that are competitive by assembling soybean varieties to find superior soybean lines (Ministry of Agriculture, 2017). Planting high yielding high yield varieties will be able to help increase soybean productivity in the increa-singly narrow growing area (Nilayati and Putri, 2015).

The number of accessions of soybean plants registered in the Genetic Resources Catalog (KSDG) of Food Crops in the Center for Research and Development of Agricultural Genetic Biotechnology and Resources (BB-BIOGEN) is 888 accessions. Superior varieties in Indonesia reach 78 varieties. The latest variety released is the Dega-1 variety which was released in 2016.

The soybean varieties released in Indonesia are mostly assembled through the crossing process, through selection of the introduction lines, selection of local varieties, and obtained through irradiation (Adie and Ayda, 2013). Assembling of superior varieties by conventional methods is done through crossing of parent plants that have superior properties to get new varieties that have properties better than their parents. The superior properties of the elders of the plant are selected based on the population of several plants from the results of the crossing that is repeated. Crosses carried out up to several generations were carried out to obtain hope lines that had superior characters. Crossing is done by crossing all the parent pairs, it can be known the potential results of a hybrid combination, the value of heterosis and the alleged heterosis of large values (Silitonga *et al*., 1993). The concept of heterosis is the basis for the activities of the formation of hybrid varieties that have advantages among other varieties or their parents. Therefore, an experiment is conducted to find out the symptoms of heterosis on soybean plants so that these symptoms can be used by plant breeders to form varieties that can provide higher yields than existing varieties.

Soybeans are food crops that are a variety of food ingredients in East Asia. Soybean plants have been cultivated since 3500 years ago in East Asia. According to Sumarno et al., (1990) cited by Cahyarini et al., (2004), soybean (*Glycine max* (L.) Merill) is a food crop that is widely cultivated in Indonesia even though this plant is not native to Indonesia. It is estimated that soybeans were introduced by Chinese migrants at the beginning of the 18th century.

An important factor in the growth and development of flowering of soybean plants is temperature. Temperatures lower than 23.9ºC will slow the flowering of soybeans. The process of flower formation, pods and seed filling will be optimal at temperatures of 26ºC-32ºC. Too high tempe-rature (> 32ºC) adversely affects the development of pods and seeds In general, soybean growth is largely determined by the height of the place, and soybeans will grow well at an altitude of 0-500 m above sea level. In Java, especially in the lowlands, soybeans are planted in paddy fields after rice cultivation, which is around July-August, with 85% of the production area located at an altitude of <100 m above sea level (AAK, 1989). Soy pods are first formed about 7-10 days after the appearance of the first flower. The speed of pod formation and seed enlargement will be faster after the flower formation process stops. The size and shape of the pods is maximal at the beginning of the seed cooking period. This is then followed by changes in the color of the pod, from green to brownish yellow when ripe (Irwan, 2006).

Soybeans are self-pollinating plants that only occur in a cross which causes an increase in the number of homozygous individuals. As a result of the cross process in this there is fixation of hereditary traits or genetic traits. Several genera-tions that experience deep crossing, cause the formation of lines in the population. The greatest diversity is seen in the diversity of lines. These lines are population groups that are genetically different (Kasno et al., 1992).

Heterosis

Heterosis according to genetic science is the effect of changes in appearance or traits on crossing offspring that are different from the appearance of both parents. This term was introduced by G.H.

Shull in 1914, after earlier since 1908 was referred to as heterozygosis. Mendel's law and the theory of quantitative genetics that began to develop rapidly at that time gave rise to two main theories that explained the basis of heterosis genetics. The first theory put forward by East and Shull in 1908 was called the overdominance theory, and the second theory offered by Keeble and Pellew and Bruce in 1910 was known as the advantage of dominance theory (Sprague, 1983) . Heterosis is the quantitative value of an increase in storage of properties of the middle elders. This increase is based on the average value obtained by the different elders crossed.

Heterosis or Hybrid Vigor according to Poehlman (1979) is defined as an increase in the size or vigor of a hybrid that exceeds the average of both parents. Symptoms of heterosis in a plant can be seen in various forms, such as plant height, leaf size, cell size, root development, increased yield and other forms. Heterosis which is positive is indicated by increasing size, growth speed and other parameters because of the increase in hetero-zygosity in the first derivative (Chapman *et al.,* 2000). Heterosis value is also often used as one of the plant breeding activities as a selection criterion to obtain the desired traits. According to Geleta et al. (2004) heterosis is the value of the difference in results between the first derivative of the result (F1) crossing with the average of the two elders or the results of the best parents. According to Wijaya et al., (2013) the value of heterosis in several parent combinations is due to the relative level of kinship of elders. The long relationship between the elders results in higher opportunities for locus with recombinant.

Role of Heterosis

Symptoms of heterosis are very wide-ranging benefits in the formation of superior plant varieties and superior culture of livestock or animals. Since the beginning of the 20th century the symptoms of heterosis have been utilized in assembling hybrid varieties. The use of hybrid varieties extends to other economical plants, such as sugar beets, sunflowers, sorghum, cotton, pearl millet, coconut, cocoa, canola, rice, and various horticultural plants (especially vegetables and ornamental plants, as well as some fruit plants). The use of heterosis through the production of hybrid varieties is considered to be part of the food revolution in the 20th century (Brwebaker, 1983). The use of heterosis symptoms is carried out on several plants such as rice plants. The use of rice hybrid varieties that utilize heterosis symptoms can increase yields 15-20% higher than ordinary varieties (Virman *et al*., 1994).

Heterosis can form the first generation (F1) of a cross that exceeds the value of both parents. Advantages in the formation of hybrid F1 according to Watt (1980 in Permadi *et. al*. 1990), namely greater vigor (increased flower or seed production, faster germination, and resistance to disease), greater adaptability to environmental conditions varies because there are genes in heterozygous conditions, the expression of beneficial traits when these traits are controlled by dominant genes, and the natural protection of varieties hijacking because breeders / companies keep their parents. Crossing between different homozygous strains can hide recessive disadvantages and restore hybrid vigor. The degree of diversity of F1 plants depends on the selection of parents who will provide heterotic hybrids. Genetic diversity determined by geographical origin is one of several methods for heterosis estimation. High heterosis values are obtained from hybrid elders that are genetically different and have high yield potential (Allard, 1999). A high heterosis value is a reflection of the results of a cross between the two parents. Heterosis which is of high value in a genotype indicates that the results of the crossing of the genotype have a higher production character than the two elders. (Arifiana, 2017). A cross between two strains can give higher results than both parents. This is even higher, especially when these lines originate from two populations with different heterotic patterns (Dahlan *et al*. 199

RESEARCH METHODS

Time and Place of Experiment

Research "Mid-Parent Heterosis Based on 20 Soybean Genotypes from Dialel Crossing 5 Soybean Elderly *Glycine max* (L.) Merrill was carried out in April 2018 at the Jember State Polytechnic Experiment Field in Jember Regency.

Materials and Experiment Tools

The research materials used were Dega-1, Gemasugen-1, Gemasugen-2, Sinabung, Gema, 20 hybrid lines, SP36 fertilizer, KCl, Urea, and manure. The tools used are scissors, buckets, hoes, sickles, threads, plastics, labels, staples and stationery.

Trial Design

This study used a randomized block design with each treatment repeated 3 times. The treatment is as follows:

A: Dega-1 variety
B: Gamasugen-1 variety
C: Gamasugen-2 Varieties
D: Sinabung Varieties
E: Gema varieties

The five varieties obtained 20 combinations of dialel crosses (meeting each other) consisting of:

1. A x B 5. B x A 9. C x A 13. D x A 17. E x A
2. A x C 6. B x C 10. C x B 14. D x B 18. E x B
3. A x D 7. B x D 11. C x D 15. D x C 19. E x C
4. A x E 8. B x E 12. C x E 16. D x E 20. E x D

Mathematical model Randomized group design (RAK) according to Sudjana (1994) is as follows:
1. $Yij = \mu + \sigma i + \alpha j + € ij$

Where:
Yij: response or observation value from the first block and jth genotype

μ: general mean
σi: influence of the i-block
αj: effect of jth genotype
€ ij: the effect of experimental errors from the i and jth genotypes

From the results of these calculations, if there are significant differences, then tested further with Scott-Knott Test with a confidence level of 95%

Heterosis testing

Symptoms of heterosis for each of the characters observed were calculated following the equations of Hallaker and Miranda (1995) as follows:

RESULTS AND DICUSCION

The average genotype appearance of the five parents and the twenty results of the dialel crosses on 10 characters is presented in Table 1. The parameters of plant height showed that thehighest plants were produced by Sinabung and Gemasugen-1 crosses. The average yield of Sinabung crosses with other varieties produces high plants while the results of the crossing of Dega-1 with other varieties produce plants that are lower than the results of other crosses. In soybean plants, plant height is an important component in contributing to the physical ability of plants and can affect other components such as the number of productive branches and the number of productive books. The ideal height of soybean plants is 75 cm (Djufry 2012).

On average at each crossing and the elders have primary branches and fertile books that are almost the same and close to their value. The elders who have the lowest fertile books are the Dega-1 variety with the number of books that produce pods on average only 11.87 books followed by low branching around 2.27 branches. Whereas for the lowest crosses the result was between Dega-1 and Sinabung which had a fertile book of 14.03 per farm and followed by a low number of branches. The parameters of flower age are not too significant or almost appear together in the phase 30-35 days after planting. Plants that have the shortest maturity of harvest are the result of Gemasugen-1 crosses with other varieties, especially in the Gema-sugen-1 and Dega-1 crosses. 16.45 grams per 100 seeds. Whereas other varieties and the results of their crosses are formed ranging from 8-13 grams per 100 seeds of Gemasugen-1 crosses with other varieties, especially in the Gemasugen-1 and Dega-1 crosses. Each plant produces 26-98 filled pods and 3-7 empty pods. The highest content of pods was produced in Gemasugen-2 crosses with Gema with an average of 98.27 pods, and Dega-1 crosses with Sinabung have fewer pods than other plants. Each plant also produces pods that do not contain soybeans. The average empty pods of each plant range from 2-7 pods. There are pods that do not contain or are empty in the books located near the top of the plant. Soybean pods produced have 1 pod, 2 or 3 seeds. The seeds formed ranged from 67-170 in the elders of soybean plants and 58-209 seeds on the results of crosses. The most seeds produced are at Gemasugen-2 crosses and Dega-1 with an average of 209 seeds. While the plants that produce the lowest seeds are found in the crossing of Dega-1 and Sinabung. Dega-1 variety has a larger seed size than other varieties so even though the number of seeds formed was only 67 but the overall seed weight per plant reaches 11.94. The weight parameter of 100 seeds shows how large the pods are in the same unit. From Table 1, it is known that the largest pods were formed in Dega-1 varieties with an average of 17.59 grams per 100 seeds. Followed by the results of the Dega-1 and Gemasugin-1 crosses with. Followed by the results of the Dega-1 and Gemasugin-1 crosses with. Followed by the results of the Dega-1 and Gemasugin-1 crosses with. Followed by the results of the Dega-1 and Gemasugin-1 crosses with. Heterosis values on plant height parameters showed that the highest heterosis value was in the crossing of Gama-sugen-2 and Dega-1. Whereas the highest decline was seen in the results of the Dega 1 crossing with Sinabung.

Table 1 Parental agronomic characters and crossing

Geno-type	Plant height.	Number Of fertile nodes	Number of branch	Flower age	Harvest Age	Number of filed Pods	Number Of Empty pods	Number Of seed per plant	Seed yield per plant	100 seeds weigt
A	43,59^{b}	11,87^{a}	2,27^{a}	30,00^{a}	90,00^{d}	31,33^{a}	3,40^{a}	67,27^{b}	11,94^{b}	17,59^{e}
B	57,81^{c}	17,67^{b}	3,47^{a}	30,33^{a}	87,33^{c}	69,07^{c}	3,20^{a}	143,67^{c}	14,44^{c}	10,07^{b}
C	57,79^{c}	17,87^{b}	2,93^{a}	30,33^{a}	81,33^{b}	51,67^{b}	2,67^{a}	114,6^{c}	8,98^{a}	7,96^{a}
D	65,91^{c}	18,07^{b}	3,73^{a}	35,00^{c}	91,33^{e}	77,60^{c}	4,00^{a}	164,47^{d}	17,55^{d}	10,81^{b}
E	61,52^{c}	17,2^{b}	3,53^{a}	35,00^{c}	88,67^{c}	82,73^{c}	4,13^{a}	170,4^{d}	18,29^{d}	10,85^{b}
AXB	45,43^{b}	16,00^{b}	2,80^{a}	30,00^{a}	91,00^{e}	51,53^{b}	2,80^{a}	120,4^{c}	19,89^{d}	16,45^{d}
AXC	56,70^{c}	19,67^{b}	3,40^{a}	31,00^{a}	89,67^{d}	71,47^{c}	3,80^{a}	142,13^{c}	18,54^{d}	13,29^{c}
AXD	34,72^{a}	14,03^{a}	2,35^{a}	30,67^{a}	91,33^{e}	26,23^{a}	2,03^{a}	58,40^{a}	7,62^{a}	12,61^{c}
AXE	43,25^{b}	18,27^{b}	3,00^{a}	30,33^{a}	91,33^{e}	58,33^{b}	3,60^{a}	123,00^{c}	10,46^{b}	8,72^{a}
BXA	48,17^{b}	19,87^{b}	3,87^{a}	30,00^{a}	87,33^{c}	62,27^{b}	3,53^{a}	132,6^{c}	11,47^{b}	8,68^{a}
BXC	46,70^{b}	18,53^{b}	3,67^{a}	30,00^{a}	88,00^{c}	67,80^{c}	4,07^{a}	141,13^{c}	13,82^{c}	9,79^{a}
BXD	46,53^{b}	18,67^{b}	3,53^{a}	30,00^{a}	87,33^{c}	64,67^{c}	2,73^{a}	140,33^{c}	13,28^{c}	9,49^{a}
BXE	49,91^{b}	18,87^{b}	3,60^{a}	30,00^{a}	91,33^{e}	85,73^{d}	4,53^{b}	184,33^{d}	15,76^{c}	8,49^{a}
CXA	61,41^{c}	17,67^{b}	3,40^{a}	30,33^{a}	74,00^{a}	97,27^{e}	3,60^{a}	209,00^{d}	17,98^{d}	8,53^{a}
CXB	54,52^{c}	17,60^{b}	2,93^{a}	30,00^{a}	74,00^{a}	68,27^{c}	2,60^{a}	145,47^{c}	12,83^{c}	8,89^{a}
CXD	52,49^{b}	19,00^{b}	3,53^{a}	30,00^{a}	81,00^{b}	79,87^{c}	2,80^{a}	171,67^{d}	15,11^{c}	8,76^{a}
CXE	59,72^{c}	19,47^{b}	3,60^{a}	30,00^{a}	85,67^{c}	98,27^{e}	4,47^{b}	202,8^{d}	18,57^{d}	9,29^{a}
DXA	59,65^{c}	18,40^{b}	3,87^{a}	35,00^{c}	88,67^{c}	98,07^{e}	4,33^{b}	206,8^{d}	22,93^{d}	11,35^{b}
DXB	65,95^{c}	18,73^{b}	3,80^{a}	35,00^{c}	88,67^{c}	81,87^{c}	3,80^{a}	174,6^{d}	19,85^{d}	11,45^{b}
DXC	64,81^{c}	16,73^{b}	3,67^{a}	35,00^{c}	89,67^{d}	74,47^{c}	3,40^{a}	162,07^{d}	15,83^{c}	10,04^{b}
DXE	59,72^{c}	18,60^{b}	3,93^{a}	33,00^{b}	92,33^{f}	79,13^{c}	5,60^{b}	168,6 ^{d}	15,55^{c}	9,40^{a}
EXA	52,12^{b}	17,73^{b}	3,80^{a}	35,00^{c}	92,67^{f}	76,65^{c}	3,80^{a}	162,47^{d}	15,66^{c}	9,78^{a}
EXB	56,69^{c}	20,93^{b}	4,20^{a}	35,00^{c}	92,33^{f}	89,13^{d}	6,47^{b}	185,4^{d}	20,41^{d}	11,36^{b}
EXC	57,99^{c}	20,27^{b}	3,67^{a}	35,00^{c}	89,67^{d}	86,60^{d}	5,47^{b}	184,67^{d}	19,17^{d}	10,61^{b}
EXD	65,29^{c}	16,53^{b}	2,93^{a}	35,00^{c}	89,70^{d}	77,27^{c}	5,40^{b}	150,27^{c}	27,81^{d}	10,76^{b}

A= Dega-1 B= Gamasugen-1 C= Gamasugen-2 D= Sinabung E= Gema
Scott-Knott Analysis with 95% confidence interval

Table. 2 Seed Yield, Plant Height, Number of filled pods, Number of Branch, Age of Flowering and Harvest Age

Geno-type	Plant height ± SE	% Heterosis	Number Of Filled Pods	% Heterosis	Number of Branch	% Heterosis	Age Of Flowering	% Heterosis	Harvest Age (R8)	% Heterosis
A	43,59±0,32		11,87±0,23		2,27±0,02		30,00±0,00		90,00±0,20	
B	57,81±0,65		17,67±0,34		3,47±0,09		30,33±0,12		87,33±0,31	
C	57,79±1,15		17,87±0,58		2,93±0,13		30,33±0,12		81,33±0,46	
D	65,91±0,19		18,07±0,48		3,73±0,02		35,00±0,00		91,33±0,12	
E	61,52±0,39		17,20±0,24		3,53±0,02		35,00±0,00		88,67±0,12	
AXB	45,43±1,22	-10,39	16,00±0,21	8,35	2,80±0,07	-2,33	30,00±0,00	-0,55	91,00±0,20	2,63
AXC	56,70±0,93	11,86	19,67±0,62	32,29	3,40±0,11	30,77	31,00±0,20	2,76	89,67±0,12	4,67
AXD	34,72±0,50	-36,58	14,03±0,70	-6,24	2,35±0,48	-21,67	30,67±0,12	-5,64	91,33±0,12	0,74
AXE	43,25±0,95	-17,71	18,27±0,57	25,69	3,00±0,14	3,45	30,33±0,12	-6,67	91,33±0,12	2,24
BXA	48,17±0,94	-4,98	19,87±0,79	34,54	3,87±0,10	34,88	30,00±0,00	-0,55	87,33±0,23	-1,50
BXC	46,70±0,41	-19,21	18,53±0,36	4,32	3,67±0,09	14,58	30,00±0,00	-1,10	88,00±0,35	4,35
BXD	46,53±0,78	-24,79	18,67±0,60	4,48	3,53±0,06	-1,85	30,00±0,00	-8,16	87,33±0,42	-2,24
BXE	49,91±0,71	-16,35	18,87±0,17	8,22	3,60±0,07	2,86	30,00±0,00	-8,16	91,33±0,12	3,79
CXA	61,41±2,57	21,15	17,67±0,21	18,83	3,40±0,12	30,77	30,33±0,12	0,55	74,00±0,00	-13,62
CXB	54,52±1,09	-5,68	17,60±0,20	-0,94	2,93±0,12	-8,33	30,00±0,00	-1,10	74,00±0,00	-12,25
CXD	52,49±0,56	-15,13	19,00±0,17	5,75	3,53±0,08	6,00	30,00±0,00	-8,16	81,00±0,69	-6,18
CXE	59,72±0,71	0,11	19,47±0,44	11,03	3,60±0,14	11,34	30,00±0,00	-8,16	85,67±0,50	0,78
DXA	59,65±0,94	8,96	18,40±0,28	22,94	3,87±0,09	28,89	35,00±0,00	7,69	88,67±0,12	-2,21
DXB	65,95±0,87	6,60	18,73±0,06	4,85	3,80±0,00	5,56	35,00±0,00	7,14	88,67±0,12	-0,75
DXC	64,81±1,58	4,79	16,73±0,61	-6,86	3,67±0,14	10,00	35,00±0,00	7,14	89,67±0,12	3,86
DXE	59,72±0,80	-6,27	18,60±0,45	5,48	3,93±0,06	8,26	33,00±0,53	-5,71	92,33±0,12	2,59
EXA	52,12±0,31	-0,84	17,73±0,78	22,02	3,80±0,12	31,03	35,00±0,00	7,69	92,67±0,12	3,73
EXB	56,69±1,02	-4,98	20,93±0,46	20,08	4,20±0,08	20,00	35,00±0,00	7,14	92,33±0,12	4,92
EXC	57,99±0,32	-2,79	20,27±0,06	15,59	3,67±0,05	13,40	35,00±0,00	7,14	89,67±0,12	5,49
EXD	65,29±0,53	2,46	16,53±0,39	-6,24	2,93±0,10	-19,27	35,00±0,00	0,00	89,70±0,12	-0,37

Table. 3 Number of filled pods, Number of empty pods, number of seed per plant, Seed weight per plant, and 100 seed weight.

Geno-type	Number of Filled Pods ± SE	% Heterosis	Number of empty pods	% Heterosis	Number of seed per-plant	% Heterosis	Seed Weight per plant	% Heterosis	100 seed Weight	% Heterosis
A	31,33±0,69		3,40±0,14		67,27±1,68		11,94±0,44		17,59±0,16	
B	69,07±0,68		3,20±0,14		143,67±1,85		14,44±0,25		10,07±0,05	
C	51,67±2,60		2,67±0,14		114,60±5,30		8,98±0,42		7,96±0,02	
D	77,60±3,51		4,00±0,26		164,47±6,49		17,55±0,92		10,81±0,19	
E	82,73±4,58		4,13±0,26		170,40±9,36		18,29±0,72		10,85±0,32	
AXB	51,53±3,21	2,66	2,80±0,07	-15,15	120,40±8,70	14,16	19,89±1,49	50,84	16,45±0,08	18,89
AXC	71,47±2,27	72,21	3,80±0,07	25,27	142,13±4,59	56,30	18,54±0,90	77,34	13,29±0,26	4,04
AXD	26,23±0,37	-51,84	2,03±0,26	-45,05	58,40±1,42	-49,60	7,62±0,31	-48,29	12,61±0,12	-11,24
AXE	58,33±1,06	2,28	3,60±0,11	-4,42	123,00±1,30	3,51	10,46±0,05	-30,76	8,72±0,11	-38,67
BXA	62,27±1,98	24,04	3,53±0,14	7,07	132,60±4,20	25,73	11,47±0,35	-13,01	8,68±0,05	-37,28
BXC	67,80±1,12	12,31	4,07±0,12	38,64	141,13±1,80	9,29	13,82±0,22	18,04	9,79±0,11	8,61
BXD	64,67±2,00	-11,82	2,73±0,14	-24,07	140,33±3,06	-8,91	13,28±0,28	-16,96	9,49±0,02	-9,04
BXE	85,73±1,09	12,96	4,53±0,08	23,64	184,33±2,23	17,38	15,76±0,08	-3,64	8,49±0,10	-18,86
CXA	97,27±1,63	134,38	3,60±0,08	18,68	209,00±2,92	129,84	17,98±0,47	71,92	8,53±0,23	-33,26
CXB	68,27±1,78	13,09	2,60±0,08	-11,36	145,47±3,59	12,65	12,83±0,48	9,61	8,89±0,12	-1,40
CXD	79,87±0,49	23,57	2,80±0,14	-16,00	171,67±0,86	23,03	15,11±0,42	13,89	8,76±0,27	-6,64
CXE	98,27±1,46	46,23	4,47±0,22	31,37	202,80±3,35	42,32	18,57±0,68	36,22	9,29±0,27	-1,20
DXA	98,07±0,81	80,05	4,33±0,14	17,12	206,80±1,24	78,48	22,93±0,11	55,55	11,35±0,04	-20,05
DXB	81,87±1,15	11,64	3,80±0,16	5,56	174,60±3,73	13,33	19,85±0,31	24,11	11,45±0,10	9,64
DXC	74,47±2,96	15,21	3,40±0,24	2,00	162,07±6,08	16,15	15,83±0,61	19,33	10,04±0,13	7,00
DXE	79,13±2,44	-1,29	5,60±0,18	37,70	168,60±4,56	0,70	15,55±0,32	-13,21	9,40±0,09	-13,20
EXA	76,65±3,66	34,40	3,80±0,35	0,88	162,47±7,04	36,72	15,66±0,59	3,65	9,78±0,06	-31,22
EXB	89,13±0,55	17,44	6,47±0,19	76,36	185,40±1,46	18,06	20,41±0,20	24,73	11,36±0,10	8,54
EXC	86,60±0,31	28,87	5,47±0,34	60,78	184,67±0,20	29,59	19,17±0,17	40,58	10,61±0,06	12,72
EXD	77,27±1,56	-3,62	5,40±0,33	32,79	150,27±2,16	-10,25	27,81±4,36	55,18	10,76±0,06	-0,68

According to Ghodrati (2013), plant height has a very real positive correlation with grain yield. Increasing plant height can cause an increase in the number of books, the number of pods, and the number of seeds per plant. The number of fertile books and primary branches mostly have positive heterosis values. The negative value of the number of fertile books was only found on the Dega-1 crossing with Sinabung, Gamasugen-2 with Gemasu-gen-1, Sinabung with Gamasugen-2 and Gema with Sinabung. Whereas in the parameter the number of primary branches the smallest heterosis value was formed at the crossing of Dega 1 and Sinabung.

When viewed from the parameters of flowering age and maturity of harvest, it seems that the nature of flowering age and maturity of harvesting from Fl plants has a tendency to approach maturity from the parents. This was indicated by the percentage of herterosis values which have a value of less than 20%. Early flowering compared to parents was very beneficial, because it has the opportunity to produce early maturing soybean plants. The speed of plants for flowering as a whole will also affect the maturity of the harvest, as stated in a statement from Sudarmadji and Sudarmo (2007), that 50% flowering has a positive correlation with plant age or harvest, which means genotypes / varieties that have 50% more flowering short, the maturity of the genotype / variety will also be shorter or commonly referred to as early maturity. The negative heterosis value at harvest age was the character desired by the character as the seed harvesting age was shorter than the average value of the two parents belonging to the hybrid vigor. The harvest age of each genotype has a different harvesting age because the age of harvest was related to plant genetic factors. This was consistent with the statement conveyed by Masdar et al., (2006) plants will enter the mature harvest phase if the total energy adopted has reached a certain level of limit (growing degree day), where each plant has certain levels that are influenced by many factors, especially genetic factors. Hererosis symptoms occur very large and significant on the results of Gamasu-gen-2 crossing with Dega-1 where the parameters of the number of pods containing heterosis value was 134.38% and the parameter of the number of seeds per plant was 129.84%. The high value due to the results formed far exceeds that of the parents. While the back crossing was only 72.21% in the number of filled pods and 56.31% in the number of seeds per plant. But if you see the seed weight per plant shows that the weight of seeds per plant between Gamasugen 2 crosses and Dega-1 values is close to reciprocal, so the large nature of the pod does not appear phenotypically at the Gamasugen-2 crossing with Dega-1. It was also characterized by the percentage of heterosis in the weight of 100 seeds from the cross which is negative. Dega-1 and Sinabung crosses have a heterosis percentage that was negative in all parameters of crop production. This was influenced by many factors including genetic and environmental. If it was based on genetic factors, the results of crosses that have a negative percentage should be at the crossing of Gamasugen-1 and Gamasugen-2. Heterotic values that are genetically negative are caused by kinship closeness between elders crossed. But there are other factors that cause seed size diversity, namely environmental reactors. According to Indria (2005) that the maximum number and size of seeds are influenced by genetic factors and environmental conditions during planting experienced when filling seeds. The condition of good planting land such as sufficient water needs and sufficient soil nutrients will make the maximum number of plants in the formation of seed filling so that the seed size will be larger and the weight of the seeds will increase.

CONCLUSION

Based on the results of the research that has been carried out, following points were concluded:

1. Each combination of dialel crosses between elders of soybean crops namely Dega-1, Gemasugen-1, Gemasugen-2, Sinabung, and Gema has different agronomic characteristics ingrowth and yield parameters
2. The results of the best crosses as a whole were produced in the Gamasugen-2 and Dega-1 crosses which showed high heterosis symptoms, especially in plant height parameters, maturity of harvest, number of filled pods, and pod weight per plant.
3. Dega-1 crosses with Gamasugen-2 have heterosis values that were positively related to all observed parameters, while Dega-1 crosses with Sinabung have values that were almost entirely negative except at harvest time that was 0.73

CONFLICT OF INTEREST

The author declared that present study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

Moh. Setyo Poerwoko designed his plant breeding program as a whole.

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