SORGHUM DIALLEL HYBRIDS ASSESSMENT FOR CROSSING SUCCESS, GERMINATION AND SEED SETTING TRAITS

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THE SUCCESS OF THREE CROSSING GENOTYPE SORGUM (SORGHUM BICOLOR LINN.) LOCAL EAST JAVA AND SEED PROCESSING TEST OF THE CROSS

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SUMMARY

For sustainable improvement in sorghum, the local germplasm genotypes were conventionally crossed with aim to determine a) the crossing success of the different genotypes, b) the germination percentage and seed setting traits, and c) the heterotic effects over mid- and better-parents in sorghum parental genotypes and their F1 diallel hybrids in East Java, Indonesia. This study aims to obtain information regarding: 1) the difference in the success rate of crossing three local sorghum genotypes in East Java, 2) the germination of the seeds from crossing three local sorghum genotypes in East Java. 3) The best value of heterosis and heterobeltiosis from cross. Three sorghum genotypes belongs to local germpalsm (Lamongan-1, Tulungagung-2, and Jombang) collected from various regions in East Java, were crossed in a complete dialle fashion.

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The said experiment was laidout in a randomized complete block design (RCBD) with four replications ~~The process of crossing plants is carried out in Purutrejo village, Purworejo sub-district, Pasuruan city, the germination testing of the seeds from the cross is carried out~~ at the Agrotechnology Laboratory, Faculty of Agriculture, University of Muhammadiyah Malang, Indonesia. T~~while planting of cross-produced seeds is carried out in the experimental field of the Faculty of Agriculture, Muhammadiyah University of Malang. The design used was a completely randomized block design consisting of 6 treatments and 4 replications. The 6 treatments were cross genotypes ♀ Lamongan-1 x ♂ Tulungagung-2; ♀ Lamongan-1 x: ♂ Jombang; ♀ Tulungagung-2 x ♂ Lamongan-1; ♀ Tulungagung-2 x: ♂ Jombang; ♀ Jombang x ♂ Lamongan-1; ♀ Jombang x Tulungagung-2. Furthermore, the parent seeds and the results of the crosses obtained were followed by a germination test using the Inter-Paper Test method. The study included 4 stages, namely: crossing the sorghum genotypes used as samples, harvesting the seeds from the crosses, testing the germination of the seeds of the parents and the results of the crosses and planting the seeds from the crosses. The results showed that t~~he sorghum cross combinations ~~of crosses of three sorghum genotypes~~ revealed significant differences for crossing success, germination, seed diameter. and seed weight while non~~had no~~ significant differences for ~~effect on the~~ number and the percentage of seeds formed ~~and the percentage of seeds formed~~. According to mean performance of all the crosses, the ~~, with the success rate for the percentage of~~ seeds formtion ~~ed~~ rangeding from 3.57% (♀ Lamongan-1 ~~x~~× ~~:~~ ♂ Jombang) to 37.50% (♀ Tulungagung-2 ~~x~~× ♂ Lamongan-1). For germination percentage, ~~The crossing of three~~ the sorghum hybrids exhibited vaaried performance i.e., the cross ~~genotypes showed different results on germination, at the~~ ♀ Lamongan-1 ~~x~~× ♂ Tulungagung-2 (0.00%) ~~cross ,~~ compared to the ♀ Lamongan-1 ~~x~~× ~~cross:~~ ♂ Jombang (100%), ♀ Tulungagung-2 ~~x~~× ♂ Lamongan-1 (88.09%), ♀ Jombang ~~x~~× ♂ Tulungagung-2 (83.33%), ♀ Jombang ~~x~~× ♂ Lamongan-1 (75.00%) and ♀ Tulungagung-2 ~~x~~× ~~:~~ ♂ Jombang (66.67%). Based on the ~~value of~~ heterosis and heterobeltiosis values, genotype Tulungagung-2 ~~can~~ produced promising F1 hybrids with ~~the characters of~~ the highest ~~grain weight and~~ seed diameter and seed weight, and the said breeding material could be ~~so that it can be~~ recommended for the assembly of superior ~~varieties~~cultivars with ~~that have~~ high productivity.

Key words: *Genotype, heterosis, heterobeltiosis, local, sorghum*

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Key findings: ~~Sorghum is a plant of the Gramineae family, such as rice, corn, wheat, and other plants such as bamboo and sugar cane.~~PUT SOME FINDINGS HERE PLEASE !!!!

INTRODUCTION

Sorghum belongs to family ~~is a plant of the~~ Gramineae ~~family~~, ~~such as rice, corn, wheat, and other plants such as bamboo and sugar cane (Sembiring et al., 2011). Sorghum is a type of grain plant that~~ has wide adaptation~~s~~ and can grow on marginal lands such as dry, alkaline, acidic or even infertile land (Sembiring et al., 2011). S~~The use of s~~orghum use is not only limited to food and feed ingredients, however, it ~~but sorghum~~ can also be used as a processed material and its seed ~~s sorgum~~ contains ash (1.6%)~~ ash~~, fat (3.1%)~~ fat~~, protein (10.4%)~~ protein~~, carbohydrates (70.7%)~~ carbohydrates~~, crude fiber (2.0%) ~~crude fiber~~ and energy (329 kcal)~~ kcal energy (Directorate of Nutrition, Dept. Health RI, 1992; Suarni , 2012)~~, and serve ~~so that sorghum is known~~ as ~~a~~ multipurpose crop~~plant~~ (Suarni, 2012; Herman et al., 2013).

Sorghum is a versatile crop~~plant~~, and ~~which is~~ useful as a food, feed, and industrial ingredient. As a food ingredient, sorghum nutrition is not much different from other cereals (ICRISAT, 2004). In general, the protein content of sorghum is higher than corn, brown rice and barley but lower than wheat. Sorghum fat content is higher than brown rice, wheat, millet but lower than corn.

Sorghum is suitable for cultivation in Indonesia because its ~~has a~~ tropical climate. Sorghum is ~~plants are~~ relatively drought tolerant, and especially could be grown in areas with low soil fertility (Panjaitan, 2015). In Indonesia, research on the development of sorghum is still very limited as ~~when~~ compared to other cereal crops such as rice, maize and wheat. The level of production and quality of sorghum in Indonesia is still low and in many regions still relies on ~~local genotype~~ cultivation of local genotypes.

Sorghum development in Indonesia face ~~One of the~~ problems of the ~~in sorghum development in Indonesia is the~~ lack of ~~development of~~ superior ~~varieties~~cultivars ~~of sorghum~~, difficulties in obtaining superior local germplasm~~seeds~~, because little work has been carried out on ~~there is still minimal~~ its development, identification and characterization ~~of sorghum~~ (Susilowati and Salim, 2013). Therefore, it is necessary to collect and develop the local germplasm~~sorghum genetics~~ to obtain wide genetic diversity in sorghum through different ~~plant~~ breeding programs. In East Java, Indonesia, presently t~~T~~his breeding program is under developmental stages ~~carried o~~and ~~ut by crossing~~ several ~~genotypes of~~ local ~~sorghum~~ genotypes have been crossed ~~plants in East Java~~ to obtain superior ~~sorghum plant~~ genotypes in sorghum.

Based on ~~the results of~~ the initial characterization of the local germplasm ~~sorghum~~ in East Java, ~~there are~~ eight sorghum genotypes (Pasuruan, Lamongan-1, Lamongan-2, Tuban, Sampang-2, Tulungagung-1, Tulungagung-2 and Jombang) have been developed with greater ~~that have the~~ potential and desirable agronomic characters and to be used in future as ~~to be developed as a~~ parental genotypes in the development of superior cultivars~~, because they have good agronomic characters, namely Pasuruan, Lamongan 1, Lamongan 2, Tuban, Sampang 2, Tulungagung 1, Tulungagung 2 and Jombang.~~ (Sulistyawati et ~~.~~al., 2019~~-~~a).

Sorghum genotype ~~The~~ Lamongan-1 has a specific criteria to mature in 77 days ~~genotype includes the genotype criteria for sorghum, which is 77 days old~~ (Sulistyawati et al., 2019~~-~~b). ~~Selection criteria f~~For development of superior ~~varieties~~cultivars of sorghum, the selection criteria ~~plants~~ includes early maturity ~~plant age~~ (70-80 days), medium plant height ~~not too high plant appearance~~ (100-140 cm), and protein and tannin content should be above 10% and ~~tannin content below~~ 0.2%, respectively (Subagio and Aqil, 2013). Sorghum genotype ~~The~~ Lamongan-1 ~~genotype~~ also had the largest excess of leaf length and width, the highest number of seeds per panicle, and the second heaviest seed weight per panicle after the genotype Tulungangung-2 ~~genotype~~. Genotype ~~The~~ Tulungagung-2 is the cultivar by having ~~genotype has an excess of genotype which is the~~ second highest plant height after the genotype Jombang ~~genotype~~, the highest 1000 ~~seeds of~~ fresh and dry seeds weight ~~and 1000 seeds of dry weight~~, the second highest number of seeds per panicle after genotype Lamongan-1 and earliest ~~the fastest~~ in flowering and harvesting compared to genotypes Lamongan-~~-~~1 and Jombang. Genotype ~~The~~ Jombang ~~genotype~~ has advantage of ~~s in~~ the highest plant height, the highest number of leaves and the highest reducing sugar content (Sulistyawati et ~~.~~al., 2019~~-~~b).

Based on above description, the present study was planned with the ~~This study~~ aim ~~s~~ to determine ~~obtain information regarding: 1)~~ a)~~the difference in~~ the crossing success ~~rate of crossing three local sorghum genotypes~~of different genotypes, b)~~ in East Java, 2)~~ the germination percentage and seed setting traits, and c) the heterotic effects over mid- and better-parents ~~of the seeds~~ in sorghum parental genotypes and their diallel crosses ~~from crossing three local sorghum genotypes~~ in East Java, Indonesia.

MATERIALS AND METHODS

The present resarch was carried out at the Faculty of Agriculture, University of Muhammadiyah Malang, Indonesia~~ocess of crossing plants was carried out in rice fields in Purutrejo village, Purworejo sub-district, Pasuruan city located at latitude -7º 39 '53.39 "latitude and longitude 112º 54' 17.38" BT~~. –Three sorghum genotypes belongs to local germpalsm (Lamongan-1, Tulungagung-2, and Jombang) collected from various regions in East Java, were crossed in a complete dialle fashion. The equipment used consists of tools for crossing activities (tweezers, colored labels, markers, waterproof paper, straples, and wool yarn), germination testing equipment (seed box, tweezers, straw paper, tissue, petri dishes, measuring cups, bottles and spray), planting equipment includes (plastic baby bag size 4 × 3 cm, and agricultural equipments). In addition, the data collection and measurement slats (stationery, rulers, calipers, analytical scales, cameras, labels and data books) were also used. ~~Plant crossing activities were carried out using a completely randomized group design (RKLT) with 6 treatments and 4 replications.~~

~~The~~ GROWN IN RICE FIELD AND germination test of cruciferous seeds was carried out at the Agrotechnology Laboratory, Faculty of Agriculture, University of Muhammadiyah Malang, while ~~planting was carried out in the experimental field at the Faculty of Agriculture, University of Muhammadiyah Malang.~~ Research activities were carried out for eight months.

Crossing process in sorghum

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The equipment used consists of tools for crossing activities (tweezers, colored labels, markers, waterproof paper, straples, wool yarn, etc.), germination testing equipment (seed box, tweezers, straw paper, tissue, petri dishes, measuring cups, bottles). spray etc.), planting equipment includes (plastic baby bag size 4 x 3 cm, agricultural equipment, etc.). In addition, data collection and measurement slats are required (stationery, rulers, calipers, analytical scales, cameras, labels and data books).

The 6 cross treatments are as follows:

♀ Lamongan-1 x ♂ Tulungagung-2

♀ Lamongan-1 x: ♂ Jombang

♀ Tulungagung-2 x ♂ Lamongan-1

♀ Tulungagung-2 x: ♂ Jombang

♀ Jombang x ♂ Lamongan-1

♀ Jombang x ♂ Tulungagung-2

Data that has been obtained from the crosses, then carried out analysis of variance and the 5% BNJ test., The germination test was carried out using the method, single plant namely conducting a germination test on the seed box without any replications.

The observation variables included quantitative characters: seed set, seed weight, seed diameter, normal and abnormal sprouts, dead seeds.

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Stages of Activities

Research carried out in four stages of activities, including :

A. Plant Crossing The

process of crossing sorghum includes 2 stages, among others :

a.Emasculation

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b. .The initial step was to prepare taken is to prepare the equipment to be used in crossing program of the sorghum. After that , then to select the sorghum flowers to be gold culated. The criteria for the chosing the flowers en flower awere: In 1 panicle 2 repetitions weare used, where in 1 repetition 3-4 secondary stalks were ill be taken. Then the samples of flowers to be crossed wereas taken. A, where at the cross of ♀ Lamongan-1 x× ♂ Tulungagung-2 there were 90 flowers, in the cross of ♀ Lamongan-1 x×: ♂ Jombang 91 flowers, in the cross of ♀ Tulungagung-2 x× ♂ Lamongan-1 were was 91 flowers , in the cross Tulungagung-2 x×: ♂ Jombang numbered 84 flowers, at cross ♀ Jombang x× ♂ Lamongan-1 were amounted to 81 flowers, and in the cross Jombang x× Tulungagung-2 there were amounted to 84 flowers. Theeis gold culation process starts from the base to the tip of the stalk secondary stalk. Then the gold culation process waის carried out by opening the husks (glume) of the sorghum flowers on one side using tweezers, then inserted ing the tip of the tweezers ion the husk to slowly remove the three stamens (anthers) ion the sorghum flowers, and finally closing the gold culated sorghum flowers using paper envelope paper., Twhere the closure of the sorghum flowers was made is done per repeat of the secondary flower stalk that has been gold culated.

Pollination

The first step was to that must be done is to prepare the equipments for pollination. T, then to take the pollen of the selected genotypes as male (Lamongan-1; Tulungagung-2; Jombang) by shaking the sorghum flower panicles slowly to get the stamens and pollen grains from stamens. Furthermore, the pollination process is carried out by opening the husk (glume) of sorghum flowers on one side of the husk using tweezers and holding one side of the husk with your fingers, after that take the pollen used as a male using tweezers then inserting the stamens vertically into the husk and remove the other side of the chaff that is held with a finger to close the sorghum flower again. Then ird, cover sorghum flowers using paper bags, where the sorghum flower cover is repeated on the secondary stalk of pollinated sorghum flowers. The final stage is labeling in the form of information on the date of the cross, replication and the parental genotypes used in of the cross (female x× male).

Harvesting of crosses seeds

The harvesting the different crosses seeds~~s~~ wa~~of the sorghum cross i~~s carried out according to the maturity and age of the sorghum ~~harvest of each~~ genotype. Harvest time was decided ~~can be done~~ by looking at the visual characteristics of ready-to-harvest sorghum on stems, leaves and panicles. These visual characteristics such as yellowing of the leaves and stems, and the formation of perfect panicles, and hardened seeds. After ~~the seeds are~~ harvesting~~ed~~, post-harvest handling wa~~i~~s carried out in the form of drying in the sun.

Germination of c~~C~~rosses s~~S~~eeds

The different ~~E~~equipments and materials ~~that will be~~ used in the germination test we~~a~~re first prepared. The crosses and their parental genotypes seeds~~s~~ were soaked in warm water (~~at~~ 40ºC) for two~~2~~ hours, after which they were soaked in a fungicide solution for 15 minutes and then dried. Furthermore, the germination test was carried out using the Inter-Paper Test method which was modified with tissue, namely by soaking three~~3~~ sheets of jaw paper and placing them in a plastic box, after which the tissue was placed on top of the jaw paper. The seeds that have been treated we~~a~~re arranged on a tissue, then covered with three~~3~~ sheets of moistened bamboo paper. The plastic boxes we~~a~~re closed and labeled with the date and genotype information, then put the plastic boxes at room temperature 23 to ~~ºC –~~30 ºC.

Planting s~~S~~eeds

After sprouting of the ~~S~~sorghum seeds and ~~sprouts that have~~ appearance of~~ed~~ radicle, the candidate genotypes we~~a~~re immediately planted in 4 ~~x~~× 3 cm polybags containing a mixture of soil + compost + husk. After ~~the age of~~ 20 days of sowing (DAS), the sorghum cultivar plants were ~~is~~ transferred to the planting area , where each hole contains one~~1~~ sorghum seed with a ~~hole~~ depth of 5 cm. For layput of the experiment, randomized complete block design (RCBD) with four replications was used.

Data recorded

The data were recorded for different quantitative characters i.e., seed setting, seed weight, seed diameter, normal and abnormal sprouts, and dead seeds.

Heterosis and h~~H~~eterobeltiosis

After getting the ~~The~~ data on the mean performance of the parental genotypes and their crosses for various traits in sorghum, the ~~obtained were calculated the value of~~ heterosis and ~~heterobiltosis~~heterobeltiosis effects were ~~with the~~ formulated as follows:~~:~~

hMP (%) = [(μF1 - μMP) / μMP] ~~x~~× 100%

hHP (%) = [(μF1 - μHP) / μHP] ~~x~~× 100%

Note:

hMP : average heterosis of parents (heterosis)

μMP ~~——~~: mean value of both parents

hHP ~~-~~: average heterosis of the highest parent (heterobeltiosis)

μHP : mean value of the highest parent (high parent)

μFmean : value of the results of the study

RESULTS

Analysis of variance revealed that ~~The combination of crosses of~~ all the sorghum cross combinations ~~three local sorghum genotypes in East Java~~ showed non-significant differences for ~~in the~~ number and percentage of seed setting and formation~~ed~~ (Table 1). The quantitative traits might be affected ~~is is influenced~~ by several factors i.e. ~~, including environmental factors,~~ pollen conditions, receptive time for female

and male anthesis and the compatibility of the genotypes used as ~~of the~~ parents~~s~~ for ~~of~~ the crosses ~~used~~. Environmental factors such as rainfall, sunlight, temperature and humidity can also affect the conception that occurs. A~~, a~~ccording to ~~the~~ opinion of Syukur et al.~~,~~ (2010), that rainfall and high temperatures will causes the low success of artificial crosses.

Pollen grains ~~(pollen)~~ are~~is~~ very susceptible to drought stress, resulting in loss of viability. This is in accordance with the opinion of Adriani and Isnaini (2010) that the viability of pollen is subject to drought stress can not return even after re-hyderated, where pollen grains~~(pollen)~~ can abe alive for ~~(viable)~~ 3-6 hours after blooming. Receptive and anthesis of flowers is the period when the flowers are ripe and ready for pollination ~~or pollination process~~. In sorghum the~~The~~ receptive time of female flowers ~~in sorghum~~ occurred for three~~3~~ days after blooming. In sorghum flower ~~T~~the pistil (Stigma) ~~of the sorghum flower~~ began receptive two~~2~~ days before the flowers bloom, and up to 8-16 days after the flowers bloom, however, but optimal receptivity remains for for 3 three days after blooming (Andriani and Isnaini, 2010).

The success rate of crosses ing depends on the genotypes used as of the parents used, both as male and female parents. Based on findings research by of Syukur et al., (2010), the incompatible nature of crossing (cross compatibility) causes the failure of pollen to germinate on the pistil, failure of pollen to enter the stigma and failure of fertilized ovules to develop into ripe and viable seeds.

Seed Wweight per Seed

RBased on Table 2, the results revealed that of the crosses show that the highest seed weight per seed was obtained in from the cross of the genotype ♀Jombang x× ♂ Tulungagung-2, however, it was which was not different from the genotype Tulungagung-2 (genotype, namely 0.28 grams / seed) (Table 2). TWhile the lowest seed weight (of 0.08 g) rams / seed) was provided is the result of by F1 hybrid crossing ♀Lamongan--1 x× ♂Tulungagung-2. Genetic influence of the both parents It wais suspected that the genetic influence of the two parents on the results in of the crossing and the imperfect fertilization process. Genes in sorghum cultivarsplants affect seed height and weight, seed shape and seed size (Panjaitan, 2015). The imperfect fertilization process, as previously explained, showeds that the success of a distant relative has a smaller chance of forming a seed setting. Syukur et al., (2010) explained that the farther the kinship relationship between the two plantscultivars used in the cross, the less likely it is to get normal FI populationsplant.

Seed dof Diameter

RThe results about of the observation of that the mean vertical and day horizontal dimensions of the seeds indicated that the vertical diameter of the seeds ranged from 0.11 to cm - 0.31 cm . Wwhile the horizontal diameter ranges from 0.08 tocm – 0.18 cm. Parental genotype The Tulungagung-2 parent showeds the highest vertical diameter (0.31 cm) as well as the horizontal diameter, which does not differ from the cross between ♀Tulungagung-2 x× ♂ Lamongan-1 (0.18 cm) (Table 3). The diameter of sorghum seeds is thought to be more influenced by genetic factors. Seed size for certain plantscultivars is generally not influenced by the environment, and ~~but seed size is~~ more controlled by genetic factors of the cultivars~~plant~~ itself (Supriono et al., 2017).

Based on the analysis of the average germination potential~~power~~, the crosses ~~treatment~~ had a germination percentage of 66.67 to ~~-~~100% while the parental genotypes~~s~~ ranged from 76 to ~~-~~92%. The genotypes with ~~, where the treatments with a~~ low ~~percentage of~~ germination percentage were F1 hybrids Lamongan-1 ~~x~~× Tulungagung-2, Tulungagung-2 ~~x~~× Jombang and parental genotype Lamongan.

Heterosis and h~~H~~eterobeltiosis

For desirable germination percentage, the F1 hybrid Lamongan-1 × Jombang showed maximum values of heterosis (0.19%) and heterobeltiosis (0.09%). For seed weight, ~~T~~the highest heterosis and heterobeltiosis effects ~~values in the grain weight character~~ were recorded ~~indicated by the~~ in F1 hybrid ~~cross between~~ Jombang ~~x~~× Tulungagung~~-~~-2. In that hybrid ~~T~~the heterotic effects were ~~sis value of the seed weight at these crosses showed a~~ positive for seed weight as ~~value~~ compared to ~~the heterosis values of~~ other crosses. However, ~~Furthermore, the~~ the effects due to heterobeltiosis ~~value~~ showed~~s~~ zero values~~, this is because the middle value of F1 with the middle value of the highest parent (high parent) is the same so that the resulting heterobeltiosis value becomes 0%.~~.

For ~~The~~ vertical seed diameter, the F1 hybrid Jombang × Tulungagung-2 (-0.02%) ~~data~~ showed~~s~~ ~~that~~ the highest heterotic ~~sis~~ value. However, for ~~is in the Jombang x Tulungagung 2 cross with a value of -0.02%, while~~ the said trait the highest heterobeltiosis value was recorded ~~for the vertical grain diameter character is at~~ in the F1 hybrid ~~the~~ Tulungagung~~-~~-2 ~~x~~× Lamongan-1 (~~cross with a value of~~ -0.13%). ~~Heterosis and heterobeltiosis in the~~ For horizontal seed diameter, the F1 hybrid Tulungagung-2 × Lamongan-1 manifested the highest heterosis and heterobeltiosis values i.e., ~~were produced by cross F1 between Tulungagung 2 x Lamongan 1 with values of~~ 0.09% and 0.00%, respectively. ~~The good germination character was produced by the F1 cross between Lamongan 1 x Jombang, where the heterosis value was 0.19% and the heterobeltiosis value was 0.09%.~~

DISCUSSION

Hybridization ~~Crosses~~ is ~~are~~ one of the conventional steps in plant breeding that combine the characters of two different parents to produce superior offspring. In present ~~this~~ study, the results of crossing sorghum using three parents did not have a significant difference. This is influenced by several factors, including environmental factors, pollen conditions, female receptive time and male anthesis, and parent compatibility of the genotypes used. Environmental factors such as rainfall, sunlight, temperature and humidity can affect the conception that occurs, according to the opinion of Syukur et al., (2010) that rainfall and high temperatures will causes the low success of artificial crosses. Lopez et al., (2017) show that temperatures under 12°C reduce the quantity of viable pollen in susceptible genotypes of sorghum. Low temperature could also affect stigma receptivity. Pollen (pollen) is very susceptible to drought stress, so it quickly loses viability. This is in accordance with the opinion of Lansac et al. (1994) in Adriani and Isnaini (2010) states that the viability of pollen is subject to drought stress can not come back even after rehyderated, where pollen (pollen) can live (viable) 3-6 hours after blooming.

Receptive and anthesis of flowers is the period when the flowers are ripe and ready for pollination or pollination process. The receptive time of female flowers in sorghum occurred for 3 days after blooming. The pistil (Stigma) of the sorghum flower began receptive 2 days before flowers bloom, up to 8-16 days after flowers bloom, but optimal receptivity for 3 days after blooming (Bello, 2008 in Andriani and Isnaini, 2010).

The success rate of crossing depends on the genotype of the parents used. Based on the research of Syukur et al., (2010), that. Added by Martin (1967) in Dewi (2014), that the nature of cross compatibility, causes failure of pollen to germinate, on the stigma, failure of pollen to enter the stigma and failureof the fertilized ovule to develop into seeds that have cook and livet.

Seed weight indicates successful fertilization after crossing. If fertilization occurs correctly, the chances of producing seeds are higher, but this is also influenced by genetic factors.It is suspected that the genetic influence of the two parents on the results of the cross and the imperfect fertilization process. In accordance with the opinion of Kamil (1996) in Panjaitan et al. (2015) explained that genes in ~~plants~~cultivars affect the height and weight of the seeds, the shape of the seeds and the size of the seeds. The imperfect fertilization process, as previously explained, shows that the success of a distant relative has a smaller chance of forming a seed set.

This is in accordance with the opinion according to Syukur et al., (2010) explaining that the further the relationship the kinship between the two ~~plants~~cultivars used in the cross, will the less likely it is to get normal FI populations~~plants~~. In addition, the weight of the seeds is also influenced by the female parents used. Utomo et al., (2018) stated that female parents have a higher role than male parents, this will be the fruit of the cross from female parents.

Seed germination is also an indicator of success in crossing.This is presumed by a role for genetics. According to Kartasapoetra (2003) in Juliantisa (2017), it is stated that genetic factors that influence seed vigor are the basic pattern of germination. and growths which are genetically inherited and differ from one another other species and species. Added by the opinion of Gardner (1991) in Juliantisa (2017) explains thatseeds have low germination and vigor because the seeds are deteriorated, the seeds experience fluctuations. temperature due to rain and sunlight causing chemical composition seeds undergo changes and damage due to predator attacks like an insect or a bird and that causes the seed to experience damage, which in turn will reduce the quality and quality of the seeds.

The phenomenon of heterosis and heterobeltiosis is widely used by breeders to compare the appearance of F1 with its parents. According to Utomo et al., (2018) stated that the occurrence of heterosis is caused by the expression of genes from the two parents passed down through crossovers. Based on this, it shows that the heterosis value can be used as a reference whether the results of crosses (F1) have the potential to be the desired ~~variety~~cultivar or not for the breeding process. The value of heterosis and heterobeltiosis on the grain weight character was shown by the cross between Jombang ~~x~~× Tulungagung 2 with a positive value compared to other crosses. Krisnawati and Adie (2011) positive heterosis indicates that the trait in question is dominant, conversely if it is negative, then the character is recessive. In addition, Wiguna and Sumpena (2016) state that heterosis will be positive if the appearance of the hybrid is better than the average of one parent or the average parent, otherwise negative if one parent or the mean value of the two parents is better than the average of the hybrid. Based on the character of seed weight, vertical seed diameter and horizontal seed diameter, the highest heterosis and heterobeltiosis values were the highest by crossing Jombang ~~x~~× Tulungagangung 2 and Tulungagung 2 ~~x~~× Lamongan 1 and Tulungagung 2 ~~x~~× Lamongan 1. This shows that the genotype of Tulungagung 2 is good as Male and female parents will produce F1 with the characters of the highest grain weight, vertical and horizontal seed diameter so that the genotype of Tulungagung 2 can be recommended for the assembly of superior ~~varieties~~cultivars that have high productivity.

CONCLUSIONS

Based on the current findings, ~~the results of this study,~~ it can be concluded that ~~:~~

~~The~~ cross combinations ~~of crosses of three sorghum genotypes~~ had no significant effect on the number and percentage of seeds formed ~~and the percentage of seeds formed~~, with the success rate ~~for the percentage~~ of seeds formation~~ed~~ ranged~~ing~~ from 3.57% (♀Lamongan-1 ~~x~~× ~~:~~ ~~♂~~ Jombang) to 37.50% (~~♀~~ Tulungagung-2 ~~x~~× ~~♂~~ Lamongan-1). For germination, the sorghum crosses

~~The crossover of three sorghum genotypes~~ showed varied ~~different~~ results ~~on germination at the ilangan~~ i.e., Lamongan-1~~x~~× ♂Tulungagung-2 ~~cross~~ (0%), compared to four other F1 hybrids ~~the~~ ~~♀~~ Lamongan-1 ~~cross x~~× ~~:~~ ♂ Jombang (100%), ♀Tulungagung-2 ~~x~~× ♂Lamongan-1 (88.09%), ~~♀~~ Jombang ~~x~~× ~~♂~~ Tulungagung-2 (83.33%), ~~♀~~ Jombang ~~x~~× ~~♂~~ Lamongan-1 (75.00%) and ~~♀~~ Tulungagung-2 ~~x~~× ~~: ♂~~ Jombang (66.67%).

Based on the values of heterosis and heterobeltiosis, genotype Tulungagung 2 could ~~an~~ produce promising F1 populations with desirable traits ~~with the characters of the~~ like the highest seed diameter and seed~~grain~~ weight. Therefore, the said breeding material ~~and seed diameter so that it~~ ~~c~~could be ~~an be~~ recommended for the assembly of superior ~~varieties~~cultivars with ~~that have~~ high productivity.

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Table 14. Mean performance of parental genotypes and their F1 diallel hybrids of sorghum for different types of Average of Live Ssprouts and , Normaly of Sprouts, Abnormaly of Sprouts, Succumb Sprouts and the Ggermination power of Three Genotypes of Local Sorghum in East Java.

Genotypes	Average					Germination power %)
	Number of Ssemai (#)	Live sprouts	Normal sSprouts	Abnormal sSprouts	Succumb sSprouts	
Parental genotypes						
Lamongan-1	25	21	19	2	4	76
Tulungagung-2	25	24	23	1	1	92
Jombang	25	24	23	1	1	92
F1 Hybrids						
Lamongan-1 x× Tulungagung-2	2	0	0	0	2	0
Lamongan-1 x× Jombang	2	2	2	0	0	100
Tulungagung-2 x× Lamongan-1	12	11	10	1	0,67	88,09
Tulungagung-2 x× Jombang	2	2	1	0	0,5	66,67
Jombang x× Lamongan-1	3	3	3	0	0,5	75
Jombang x× Tulungagung-2	9	9	8	1	0	83,33

Table 21. Seed setting in F1 diallel hybrids of sorghumResults of the Success Test of Crossing Three Genotypes of Local Sorghum in East Java: Number of seeds formed, Percentage of seeds formed, Average number of seeds formed and Average percentage of seeds formed.

Crossing	Repetitions	Flowers crossed (#)	Seeds formed (#)	Seeds formed (%)	Average seeds formed (#)	Average seeds formed (%)
Lamongan-1 x× Tulungagung-2	1	20	0	0	1,0 a	4,38 a
	2	20	1	5		
	3	24	3	12,50		
	4	26	0	0		
Lamongan-1 x× Jombang	1	25	0	0	0,75 a	3,57 a
	2	21	2	9,52		
	3	21	1	4,76		
	4	24	0	0		
Tulungagung-2 x× Lamongan-1	1	25	9	36	9,0 a	37,50 a
	2	21	0	0		
	3	25	21	84		
	4	20	6	30		
Tulungagung-2 x× Jombang	1	22	1	4,55	1,0 a	4,89 a
	2	22	0	0		
	3	20	0	0		
	4	20	3	15		
Jombang x× Lamongan-1	1	21	4	19,05	1,5 a	7,26 a
	2	20	0	0		
	3	20	2	10		
	4	20	0	0		
Jombang x× Tulungagung-2	1	23	14	60,87	4,25 a	18,97 a
	2	21	0	0		
	3	20	3	15		
	4	20	0	0		

Annotation-: The numbers followed by a same alphabetical in the same column show the unreal

Table ~~3~~2. Mean performance parental genotypes and their F1 diallel hybrids of sorghum for seed weight~~Average Weight per Cross of Three Genotypes of Local Sorghum in East Java~~.

Genotypes	**Seed w~~W~~eight ~~per seed~~ (g)**
Parental genotypes	
Lamongan-1	0,025
Tulungagung-2	0,028
Jombang	0,023
F1 Hybrids	
Lamongan- 1 ~~x~~× Tulungagung-2	0,008
Lamongan-1 ~~x~~× Jombang	0,019
Tulungagung-2 ~~x~~× Lamongan-1	0,017
Tulungagung-2 ~~x~~× Jombang	0,019
Jombang ~~x~~× Lamongan-1	0,020
Jombang ~~x~~× Tulungagung-2	0,028

Table 43. Mean performance parental genotypes and their F1 diallel hybrids of sorghum for seed diameterAverage Diameter of Crosses of Three Local Sorghum Genotypes of East Java.

Genotypes	**Seed dof Diameter (cm)**	
	Vertical	**Horizontally**
Parental genotypes		
Lamongan-1	0,28	0,15
Tulungagung-2	0,31	0,18
Jombang	0,20	0,15
F1 Hybrids		
Lamongan-1 x× Tulungagung-2	0,12	0,08
Lamongan-1 x× Jombang	0,11	0,08
Tulungagung-2 x× Lamongan-1	0,27	0,18
Tulungagung-2 x× Jombang	0,14	0,10
Jombang x× Lamongan-1	0,16	0,11
Jombang x× Tulungagung-2	0,25	0,15

Table 5. **Heterosis (MP) amd heterobeltiosis (HP) values among sorghum F1 diallel hybrids for germination, ~~Avarge of S~~seed w~~W~~eigt, and s~~S~~eed d~~D~~iameter (v~~V~~ertical and ~~), Seed Diameter (H~~horizontal)~~, Seed Diameter (Vertikal),Germination Heterosis and Heterobeltiosis of Three Genotypes of Local Sorghum in East Java~~.**

F1 Populations	**Germination (%)**		**Seed weight (%)**		**Seed diameter - ~~(~~Vertical~~)~~ (%)**		**Seed diameter - ~~(~~Horizontal~~)~~ (%)**	
	MP	**HP**	**MP**	**HP**	**MP**	**HP**	**MP**	**HP**
Lamongan-1 ~~x~~× Tulungagung-2	-1.00	-1.00	-0.70	-0.71	-0.59	-0.61	-0.52	-0.56
Lamongan-1 ~~x~~× Jombang	0.19	0.09	-0.21	-0.24	-0.54	-0.61	-0.47	-0.47
Tulungagung-2 ~~x~~× Lamongan-1	0.05	-0.04	-0.36	-0.39	-0.08	-0.13	0.09	0.00
Tulungagung-2 ~~x~~× Jombang	-0.28	-0.28	-0.25	-0.32	-0.45	-0.55	-0.39	-0.44
Jombang ~~x~~× Lamongan-1	-0.11	-0.18	-0.17	-0.20	-0.33	-0.43	-0.27	-0.27
Jombang ~~x~~× Tulungagung-2	-0.09	-0.09	0.10	0.00	-0.02	-0.19	-0.09	-0.17