A review on heterosis and combining ability analysis of seed yield and oil contents in rapeseed (*Brassica napus* L.)

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Abstract: Brassica has been an important source of edible oil. The yield enhancement along with good quality oil is main objective of brassica breeders. In any hybridization program, recognition of the best combination of two (or more) parental genotypes to maximize variance within related breeding populations, and as a result the chance of recognizing superior transgressive segregants in the segregating populations, are the most critical challenge to plant breeders. Although considerable progress has been made in crop improvement by plant breeding, it is essential that it continue. Through commonly applied breeding techniques, current breeding programmes continue to evolve. Combining ability could largely contribute in achieving this object. Combining ability as a considerable analysis tool is not only useful for selecting favourable parents but also provides information concerning the nature of and importance of gene effects influencing quantitative traits. Heterosis (or hybrid vigor) is a natural phenomenon whereby hybrid offspring of genetically diverse individuals display improved physical and functional characteristics relative to their parents. Heterosis has been increasingly applied in crop production for nearly a century, with the aim of developing more vigorous, higher yielding and better performing cultivars. Heterosis has been widely exploited and utilized in rapeseed breeding. Reliable and precise prediction techniques of heterosis contributed in accelerating the crossbreeding and reducing the cost of large-scale field evaluation.

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1. Introduction

The oilseed Brassicas are the world's third most important source of oils and their production has witnessed a steady upward movement by the aim of conventional and modern plant breeding approaches (Sabaghnia *et al*., 2010). In rapeseed breeding for hybrid and open pollinated varieties, general and specific combining ability effects (GCA and SCA) are important indicators of the potential of inbred lines in hybrid combinations. The relative importance of additive (GCA) and non-additive (SCA) gene actions within a breeding population is important to determine which breeding procedure will efficiently improve the performance of the characters of interest (Singh and Chaudhury, 1977). Exploitation of genetic variability in any crop species is considered to be critical for making further genetic improvement in grain yield as well as other economically important traits (Rehman *et al*., 2009). The limited geographic range of *Brassica napus* combined with intensive quality breeding has led to narrow genetic basis in this species (Seyis *et al*., 2005).

Heterosis is a natural phenomenon whereby hybrid offspring from genetically diverse individuals show increased vigor relative to their parents (Shull 1948). Heterosis in crop species can be visualized in terms of increases in growth rate, total biomass, stress resistances, seed yield, and population fitness (Kalloo et al. 2006). Heterosis has the following specific characteristics: firstly, heterosis is highly variable; the degree of heterosis varies with respect to the genetic distance of the parents, their reproductive mode, the traits investigated (Zhou et al. 2012), the developmental stage of the plants (Grosz-mann et al.2013) and the environment. With respect to environmental variation, biotic and abiotic conditions shown to affect heterosis include soil-type, topography, climate, solar energy, temperature and water availability (Blum 2013). Secondly, heterosis is largely universal and can increase crop yields by 15–50 % depending on crop type. Many of the major cereal crops as well as commercial varieties of vegetable and flower crops are populated using hybrid seeds for increased agricultural performance (Birchler et al. 2003).

Three categories of heterosis have been defined based on the genetic distance of parental lines. These are: (1) intraspecific heterosis, resulting from crosses between two accessions belonging to the same species, (2) intersubspecific heterosis, resulting from crosses between two subspecies, and (3) wide-hybridization heterosis, resulting from crosses between two individuals of a different species or genus. In certain contexts, there is a clear positive correlation between the genetic divergence of the parent lines and heterosis potential, which is evidenced in subtropical maize (Reif et al. 2003), winter rapeseed (Ali et al. 1995).

1.1 Intraspecific heterosis

Intraspecific heterosis is the favored choice of most breeders because it can be manipulated easily and results in lower breeding costs, higher breeding efficiency and better seed-set (for seed-based crops) compared with wide-hybridization heterosis. To avoid the low levels of heterosis associated with crossing closely-related lines, crop breeders classify intra-species parental materials into heterotic groups based on molecular markers or physically testing combining ability. Each heterotic group fixes different alleles, which when combined with allele (s) from the opposite heterotic pool, can result in higher vigor. These positive interactions form the base for the superior performance of the heterotic pattern (Schon et al. 2010). Reciprocal crossing between these groups allows evaluation of the hybrid to determine the optimal combination of parents and establish a heterotic pattern and crossing regime (Melchinger and Gumber 1998).

Rapeseed has been divided into three heterotic groups: Asian rapeseed (including rapeseed from China and Japan), European winter-type rapeseed, and Canadian and European spring-type rapeseed. Hybrids obtained from crossing between Asian and European varieties exhibit stronger heterosis than hybrids obtained from crosses within the Asian or European groups (Qian et al. 2009). Crosses between spring rapeseed and Chinese semi-winter lines show great potential to increase seed yield (Qian et al. 2007). The cross of resynthesized B.napus to European winter oilseed rape also creates higher heterosis (Girke et al. 2012). In all, 86 oilseed rape cultivars have been divided into four distinct groups: I (mainly consisting of exotic cultivars), II (mainly composed of Chinese cultivars), III (mixed cultivars from China and Europe) and IV (mainly comprising exotic and newly synthesized yellow seeded lines) (Younas et al. 2012).

1.2. Heterosis from wide hybridization

Wide hybridization is defined as a cross between two individuals of at least species-level divergence. Examples include Brassica oleracea (cabbage/cauliflower) × B. rapa (Chinese cabbage), B. oleracea × Raphanus. With respect to wide hybridization, as long as geographical and reproductive isolation exists between species, strong hybrid vigor is observed, but similarly to intersubspecific crosses, poor seed setting and genetic instability often occur. Wide hybridization in vegetable crops is aimed directly at increasing vegetative growth, or biomass. For example, interspecific hybrids between B. napus and the less cultivated B. campestris display a mid-parent heterosis (MPH; difference between the hybrid and mean of the parents) of 35.6 % for biomass and 72.4 % for branch number (Wang et al. 2003). In another study, hybrids between B. napus and B.campestris or B. rapa showed approximately 34 % MPH for biomass production (Liu et al. 2002). One breeding strategy that utilizes wide hybridization involves finding methods to introgress an alien species' DNA into a genotype of another species to produce a novel, fertile accession with a normal chromosome number. Subsequent hybridization between this introgressed accession and natural accessions of the same species often give rise to stronger heterosis. For example, a hybrid between natural B. napus (amphidiploid genome AACC) and resynthesized B. napus that carries genomic components from B. rapa (diploid AA) and B. carinata (amphidiploid BBCC) can exhibit stronger heterosis than an intraspecific natural B. napus hybrid (Qian et al. 2005). Resynthesized allotetraploid B. napus derived from a cross between B. oleracea (CC genome) and B. rapa was recently evaluated as a diverse B. napus germplasm for hybrid breeding (Girke et al. 2012). While these resynthesized lines are not competitive with current elite cultivars for yield traits, hybrids between these lines exhibited heterosis for yield and seed oil content (Girke et al. 2012). However, genomic instability and unsustainable phenotypic variation may impede the application of this type of heterosis.

Heterosis and heterobeltiosis have extensively been explored and utilized for boosting various quantity and quality traits in different crops (Mahmoud and Ahmed, 2010). With sufficient level of heterosis, commercial production of hybrid varieties would be justified (Radoev *et al*., 2008) The availability of genetically distant plant material is of great importance for successful hybrid breeding programs because breeders want to exploit the expected heterosis effects. This effect is higher in cases where the parents are relatively different on genetic base. The extent of heterosis in rapeseed has been analyzed in a number of studies with widely varying results, depending on the materials used. For grain yield in spring rapeseed hybrids, an average high parent heterosis of 30% with a range of 20-50% was observed, while for winter rapeseed hybrids an average high parent heterosis of 50% was reported, ranging from 20 to 80% as reviewed by McVetty (1995). Flowering is the most critical stage influencing the yield of oilseed rape (Faraji *et al*., 2008). The unset of flower initiation can have strong influence on flower, pod and seed number (Yasari and Patwardhan, 2006). Habekotte (1997) used a sensitivity analysis within a crop growth model to study options for increasing grain yield in winter oilseed rape. The most promising crop type for high grain yield combined late maturity with early flowering (Downey and Rimmer, 1993). Heterosis is commercially exploited in rapeseed (*Brassica napus* L.) and its potential use has been demonstrated in turnip rape (*B. rapa* L.) and Indian mustard (*B. juncea* L.) for most agronomic traits (Zhang and Zhu, 2006). Early flowering in brassica can provide adequate time for grain formation process and can certainly cause early maturity and higher yields; therefore negative heterosis is desirable for flowering. Significant negative mid-parent and better-parent heterosis were reported for days to 50% flowering and physiological maturity (Nassimi *et al*., 2006).

Majority of Pakistani population directly or indirectly rely upon the agricultural sector so agriculture is considered as the main contributor in Pakistan's economy. Better yield and development of major field crops like cotton, wheat, maize, rice and pulses have a positive effect on the progress of agriculture in the country. In addition to these major crops, oilseed crops provide oil used for both industrial as well as domestic purposes. Pakistan is a country blessed with a fully supporting environment for the cultivation of many oilseed crops which fulfill our local requirements and are grown once or twice a year. Edible oil is an important part of routine diet in Indo-Pak subcontinent especially in Pakistani rural masses. It enhances the palatability and is also an essential component of human diet.

The *B. napus* has advantages over other brassicas as its oil contains two very important fatty acids i.e. linoleic and linolenic that are absent in many other oilseeds moreover it contains very less amount of harmful fatty acids. Oil percentage is 28.6 to 45.7% in it (Turi *et al,* 2006). In addition to these qualities it is superior to other brassicas due to its early maturity, shattering resistance, less erusic acid, good seed production and low glucosinolates. So, in the future it will be the best oilseed crop of the world. It occupies second position in in protein meal used in the poultry and livestock industry for animal feeding (Azizinia, 2012). During 2015-16, 2.11 million hectares area was cultivated with it and there was 1.94 million tons of oilseed production in Pakistan. Its production declined in 2015-16 by 1% in relation to previous year (Govt. of Pakistan, 2015-16). In the same era (July-March) of 2015-16 edible oil of value Rs.136.920 billion (US$1.392 billion) that is 2.205 million tones was imported which was 24.5 percent more as compared to the same period in 2014-15.

In Pakistan preference is given to the major or sometimes called cash crops, so despite the significance in the economy and trade of Pakistan, oilseeds are being neglected by poor agronomic sector and farmers. This dearth of edible oil is contributed by a lot of factors e.g. non- availability of proper and timely agricultural inputs, cultivation on marginal lands, competition with wheat like major crops, dearth of developing short duration and early maturing varieties and proper attention is not given towards the genetic upgrading of oilseed crops. The population of Pakistan is growing progressively in comparison to other South Asian countries. So, in present situation it is highly demanding to give more attention to the oilseed crops by better varieties development having valuable quantitative and qualitative attributes. By adopting the modern techniques of breeding we can not only feed our presently increasing population at faster rate, but can be import to other countries. According to an estimate if there is an increase of oilseed yield about 2.3-2.5% can boost up the oil quantity up to 1% at country level in it (Ali *et al.,* 2014).

To increase the quality and yield potential of brassicas information about the combining ability and other genetic mechanisms is therefore of much importance. Capacity of a genotype to pass down its superior attributes to its progeny is called as its combining ability. Value of an inbred is mostly judged by its ability to yield superior hybrids a compared with other inbred. Therefore, exact information about the combining abilities of existing parents to be used in any breeding scheme is necessary for improvement in yield and traits related to yield.

For the evaluation of gene action and SCA and GCA, line $_x$ tester analysis is an excellent tool. It is very helpful for selecting desirable parents and crosses for any rapeseed breeding scheme. Besides this it also creates data of genetic mechanisms which controls some characters (Rashid *et al.*2007). General combining ability ascribed to additive gene effects which can be fixed. But specific combining ability is ascribed to non-additive gene action that cannot be fixed and are may be because of dominance or epistasis (Malik *et al.,* 2004).

Grami *et al*. (1977) studied the protein and oil contents of *B. napus* on the basis of genetic inheritance. To serve the purpose, high and low protein parents are used. The results depicted that in parameters expression, the action of additive genes are involved. Results also confirmed the epistasis absence and non-significant Dominance.

Buson *et al*. (1982) performed a trial on *B. napus* genotypes for determination of hybrid vigor. 140 F_1 hybrids were reportedly involved in different yield attributing characters. In term of seed yield, 23.5% was the average value recorded in mid parent heterosis that could be elevated up to 50% in some crosses. The degree of heterosis varied upon time and space.

Sheoran *et al*. (2000) explained the combining ability by using three testers and nine lines of brown sarson of different traits. The results showed that all parameters like plant height, shoot length, primary branches plant^{-1}, secondary branches per plant, 1000 seed weight, seeds/silique, silique length and yield of plants had noteworthy GCA and SCA. The effect of environments on GCA and SCA was vivid. In study parents (DBS1, Pusa, Kalyani, BSIK and BSH1) proved good for yield and related characters as general combiner. The cross combinations of BSC199 x BSH1 and BSIK1 x BSIK2 were proved best. Thus, in inheritance of different traits the role of additive and non-additive is essential.

Rameeh *et al.* (2003) performed a trial to study the variation on genetic base for glucosinolate and other yield related contents. Different genotypes having different backgrounds of B. napus were used to make all possible combinations. Except 1000 seed weight, all parameters showed effect of General and specific combining ability. In 1000 seed weight, only General combining ability's effect was significant. Narrow sense heritability showed by glucosinolate contents and 1000 seed weight revealed the essentiality of additive type of gene action. In all parameters, Maternal mean squares was significant but in length of pod ratio a/b mean squares was also significant which related it to the additive type of gene action's importance.

Nair *et al*. (2005) reported an experiment for identification of better parent in context of specific combing abilities. Results showed the significant variance of lines and testers in all traits except days to maturity. For yield and yield related parameters, two crosses were extraordinary.

Tahira *et al*. (2005) estimated the heterosis and heterobeltiosis of brassica by evaluating ten cultivar's F_1 generation. All traits showed significant results. The characters like plant height, branches per plant, no. of seeds/silique, 1000-grain weight and seed yield/plant showed significant heterosis by crosses of KS-75 with COON-II, CON-III, Shiralee and Rainbow. In case of KS-75 x Ac. Excel, highest heterosis was found for oil content. Thus, for betterment of Pakistan's Brassica oilseeds these parents and crosses can be used and selected for future.

Nassimi *et al*. (2006a) studied the *Brassica napus* L. lines for estimating the gene action and combining ability. The siliqua per main raceme, primary branches and 50% flowering days showed significant general combining ability while plant height and maturity days showed non-significant general combining ability. On the other hand, SCA effects were proved significant in all traits. The presence of these traits was mainly controlled by additive gene action.

Nassimi *et al*. (2006b) identified the best combiner lines on inheritance basis. Results depicted that siliquae/plant, no. of seeds/plant and siliqua length showed significant in GCA while GCA was non-significant for plant yield and 1000 grain weight. In term of specific combining ability, yield, weight of 1000 grain, siliqua length, Maturity days and siliquae/plant were highly significant. The specific combining ability showed lowered effect in comparison to general combining ability.

Qian *et al*. (2007) conducted an experiment in semi-winter and spring on rapeseed lines to estimate the breeding potential, to evaluate the heterosis, G and SCA, and determined the genetic impact for different crosses of rapeseed. For testers 13 Chinese rapeseed winter lines and 4 male sterile lines was used to make 52 hybrids and then line x tester pattern was followed for crossing. Then determine the quantitative and qualitative traits of all these parents, hybrids and crosses of rapeseed. Results portrayed the highest seed yield heterosis of hybrids and additive gene action enhanced their performance. GCA mean square had higher values in comparison to SCA mean square. Overall, the Chinese lines showed remarkable prospective in improvement of Brassica.

Ahmad *et al*. (2008) studied the locally developed "HS-98" that was better than commercially cultivated *Brasssica napus* L. varieties. Results showed that agronomic traits (1000 seed weight, Silique/plant and siliqua length) were markedly improved. The siliqua length was 6.7 cm and no. of Silique/plant was 156. Compared to all checks (*Brassica napus* L. Rainbow, Oscar and Dunkled), HS-98 showed highest protein content (25.1 %).

Amiri-oghan *et al.* (2009) studied the yield, maturity days and flower initiation of *Brassica napus (*L.). The analysis showed that all traits of observation were controlled by additive and non-additive mode gene action. The ratio of GCA to SCA was reported 0.91 for flowering, 0.83 for yield and 0.95 for maturity day. While for all traits, additive gene action played essential role. Thus, for early maturity Regent and Tower were proved best parents and for high yielding Ceres and D. R. were best suited.

Huang *et al.* (2009) evaluated the yield attributes of Brassica by performing combine ability analysis. To obtain hybrids, as female parents 5 male sterile lines were used and as male parent 9 inbred lines were used. Different locations were used for parents and hybrids testing. All characters showed significant GCA effects except seed yield and all characters showed significant SCA mean squares except physiological maturity days. Overall, GCA effect was pronounced but in some characters like flowering days, seed yield and oil content revealed major SCA response which related the involvement of non-additive gene action for parameters expression.

Nigam and Alka (2009) evaluated the inheritance pattern by controlling quantitative traits and 45 hybrids of *Brassica napus* L were kept under observation. The GCA and SCA were reported also. The GCA and SCA variance representing the role of additive and non-additive gene action in various traits control. Overall, non-additive genetic action reported 16 hybrids showing go. od GCA for *Brassica napus* L yield.

Aghao *et al.* (2010) evaluated the role of GCA and SCA on different yield attributing parameters. Ten different genotypes having different background of *B. juncea* were used to obtain hybrids of F_1. The results obtained revealed the significant effects of all parents and crosses. Siliquae/plant, seed yield and 50% flowering showed significant GCA variances. While, plant height, seed yield/plant, siliquae/plant and 50% flowering days showed significant SCA effect. The mea square of SCA was lower as compared to GCA which represented that parents had more genetic variation than crosses.

Sabaghnia *et al.* (2010a) determined the yield attributed characters and oil content by crossing *B. napus* genotype sin diallel scheme. Additive gene models were used to evaluate 36 F_1 hybrids. All traits showed significant differences after Analysis of variance. Plant height depicted dominant genetic variance component, whereas lateral branches /plant and flowering days showed significant additive genetic variance.

Sabaghnia *et al*. (2010b) explained the effects of combining ability of *B. napus* using diallel scheme and nine genotypes. Mean square of SCA and GCA indicated significant results. Among all the observed traits, the effect of SCA was higher compared to GCA depicting the dominance of non-additive type of gene action.

Cuthbert *et al.* (2011) studied the seed quality characters in rapeseed hybrids are either due to commercial heterosis or high parent heterosis. The results depicted up to 14% commercial heterosis and 9% high parent heterosis. Low parent heterosis was showed by glucosinolate and protein while erusic acid concentration showed the Commercial heterosis. In some seed quality characters, zero percent heterosis was showed by various hybrids. Overall, high erusic acid varieties proved significant in seed quality characters like oil concentration.

Etedali *et al*. (2011) determined the combining abilities by using rapeseed's five inbred lines for three in-vitro traits like callus weight, callus diameter and callus induction. The variance of GCA was smaller than SCA depicting the dominance type gene action. This dominance type gene action indicated the low narrow sense and high broad sense heritability in traits control.

Rameeh (2011) explained the *B. napus* yield attributing traits by estimating heterosis and combining ability effects. 6 lines of winter type rapeseed were crossed with 2 testers of spring type to obtain F_1 hybrids. For all characters mean squares were found significant which indicated the remarkable genetic variation among crosses and parents. For all traits significant average heterosis was found except in siliquae/plant. 1000 seed weight showed Narrow sense heritability highest values which depicted the dominance of cumulative genetic effects.

Zhang *et al*. (2011) determined the erusic acid and glucosinolate heterosis in rapeseed. For erusic acid and glucosinolate estimation; cytoplasmic heterosis, embryo heterosis and maternal heterosis was studied. For two years crosses of parents were made. Genotype × phenotype and genetic effect controlled glucosinolate and erusic acid heterosis. For erusic acid all crosses portrayed the positive heterosis, while in case of glucosinolate heterosis conditions were not the same. Hybrids showed significantly negative maternal heterosis and Positive embryo heterosis. Thus, in rapseed interaction and maternal general heterosis were vital foe alleviating the erusic acid and glucosinolate contents. In conclusion, genotypes of small erusic acid and glucosinolate amount were used in development of canola varieties in future.

Arifullah *et al*. (2012) studied eight genotypes and crossed them in all possible ways. GCA was significant in all traits except in plant height and siliqua length. Results showed that for yield best combining ability was exhibited by BRS-2 and KJ-119. BRS-2 xUCD-8 had positive SCA for yield. Canola rayax UCD-8 was a good cross combination for number of seeds/silique.

Grike *et al*. (2012) Studies have shown that the re-integration of Brassica napus II is a source of fry. 44 re-assembly lines with extensive genetic variability were used to make the cross, and the two male sterile analyzers were also used for cross-point reasons. They assess the crossings in each area with their people and the standard inspection business breed for two years. Record plant height, protein material and oil material, and use RFLP markers to quantify genetic separation. Compared with the yield of the control varieties, the re-mixing yield of Brassica napus was around 85.1 and 44.6%. The yield of the semi-breed seed was different from 91.6% to 116.6%, and the deviation of the mixture was 94.5% to 103.3% compared with the control. These re-synthetic lines have no opposition to the standard species of rapeseed harvest, but can be used for changes in oilseed products due to better heterosis and broad genetic predisposition.

Abideen *et al*. (2013) Brassica napus was tested to check for changes and relationships in rape. RCBD was used to assess three replicates of genotypes. The vast majority of attributes indicate the notable difference between the genotypes being examined. The basic branch / plant and unit / plant show an unknown contrast. A significant positive relationship was demonstrated in the genotype 1 unit of each plant and protein material. If the goal is to increase oil production, then the genotype can be used as part of the reproduction procedure. Genotype 7 exhibits the best results for these characteristics when the seed yield and seed are exclusively increased.

Rameeh (2012) Using six matrila and three spring rapeseed lines to assess GCA effects, SCA effects, ultimate heritability and maternal heterosis, such as seed yield, yield fraction and plant height. Use X-ray tester cross example. It is noteworthy that there are signs of non-attached substance quality activities. The average of the parents is huge, which indicates that all quality heterosis is important, but the seed / case heterosis shows great. Each feature was evaluated, and a small infection heritability was evaluated, but the seed / unit showed an added mass of material activity. The plant height of the GCA effect is negative for hybridization. At least one of the guardians showed an adverse GCA effect on the plant body. In addition to the case / plant, all the characteristics of the parental heterosis are more pronounced than the SCA effects, from assisting in the selection of the superior pool of attractive hybridization.

Rameeh (2012a) Directed an exploration to assess the effects of seed yield, plant constitution, oil and yield on SCA and GCA in Brassica napus. He used F1 and three analyzers to deliver half and half of F1. The average of the cross and the guardian is worth noting for every character. These results demonstrate the proximity of the giant genetic changes between the guardian and the F1 mixture. All attributes show positive heterosis, seed weight and seed number / unit number other than oil removal. The high estimates of the limited heritability of most of the characters indicate the universality of the quality of the added species. It is observed that the genetic effects of additional substances are more pronounced, so the SCA mean square is critical to several people.

Rameeh (2012b) studied the effects of brushing ability, variety fecundity and heritability on the yield and quality of rapeseed (Brassica napus L.) were evaluated by line × analyzer. Seed yield and unit / plant show a significant fluctuation of the line x analyzer, and some of the non-additional material mass activities left over from these parameters are recommended. Each quality indicates a huge estimate of the mean variance of the guardian and the cross-prohibited seed / unit. Each character exhibits a high estimate of the limited heritability, in addition to the seed / unit, which presents the universality of the overall quality activity to announce the prevention of seed / case of each of these parameters.

Ahsan *et al.* (2013) evaluated the effect of hybridization on seed yield and its ability was studied. They crossed three analyzers and five European rape in a line x analyzer design. Since the average of the drug is observed to be worthy of attention, because of the great fluctuation between the guardian and the mixture, each feature. Each character also indicates a notable line of parser. It is noteworthy to observe that GCA and SCA changes are important for each attribute in the review. Compared with the SCA effect, the higher estimates of GCA effects also speculate on the effect of additional material genetic quality on all parameters, and all parameters prevent seed yield / plant. Seed yield / plant's many hybridization advantages are just as the possibility of using the semi-breed improvement to change this parameter.

Farshadfar *et al*. (2013) Using the Line × Tester cross design, using 21 lines and 3 analyzers produced 21 varieties, used to estimate the bonding capacity. As a result of the differences between GCA and SCA, quality activities are essentially an increase in the number of branches. So this role can be strengthened through early basic identification techniques. Plant height, seed yield / plant and unit / plant with non-additional material quality activities suitable for heterosis breeding. RGS003 is a woman with the greatest GCA effect on various parameters, such as No. On the other hand, Option500 is used as a feature to provide the most noteworthy GCA analyzers, such as 1000 grain weight and seed yield. Magent × opera, Shiralee × opera and election × Option 500 is the highest SCA to get the cross.

Kumar (2016) by investigating with the line x analyzer, B. juncea genetic testing was carried out to obtain oil content and other quality parameters. They pass through the twenty lines and four analyzers to get the F1 frequency. All the guardians and crosses are showing a striking contrast to every feature in their thinking. It was observed that oleic acid corrosion and corrosive substances were affected by natural elements, while the declarations of different parameters were poor. A high estimate of the heritability of oleic acid corrosion indicates the effect of additional material on the genetic impact of the declaration of this property.

Kang *et al.* (2014) made a review to find out the impact of GCA and SCA on European rape production and yield credit quality. They crossed eight lines in a line x analyzer plan. The consequences of the variance analysis show that each guardian of each person is completely different from half and half of them.

Taking into account each quality, the impact of SCA and GCA is huge. Compared with the mean square of SCA, the Mena squares of SCA were higher, and the ability of non-attached matter mass activities to flow out of these parameters was proposed.

Meena *et al*. (2015) evaluated a total of 36 F1 semi-breeds and 13 B. juncea guardians were evaluated to deal with better maternal heterosis and different yield attribution properties of the standard heterosis. On the proof, the guardian and F1 half and half of the difference is basically every character. Many crosses show a profound estimate of the heterosis of important branches, indicating the first branch, representing 1siliqua, seed / case and original shot length.

Kang *et al.* (2014) studied the impact of cross-breed life and integration capacity on European rape was reviewed. They crossed 11 lines and 5 analyzers, with a specific goal to make F1 half and half. The guardian and each of the crosses have a serious contrast to the person being examined. It is observed that the root mean square of the lines is huge for all the characters that prohibit the plant body. The changes in the analyzer show great limitations on all attributes that prohibit the plant / plant and plant body. The observed results are critical for the line of all parameters considered. It was observed that the SCA effect was higher than that of the GCA on all the characters. 7 cross V 22 × KN (20-35), star × 20-E, Man Luo × B-9527-1, S9 × 5F, CRS 5 × B-9527-1, CRS 5 × KN (20-35), CRS5 × 20 - indicates critical heterosis and SCA changes.

Nasim *et al*. (2013) evaluated the connection capacity of the press yield characteristics was evaluated. The length of the case, the seed yield per plant, the weight of 100 seeds, the case of each basic germplasm, and the necessary branches of each plant are broadly unique. The heritability assessment is directed to each basic germplasm unit, the essential branch of each plant, the weight of 100 seeds, and the seed yield per plant is high. G-902, the number of seeds per plant, the number of seeds of each genus, the genotype G-403 of the 100 seed weight, and the length of the gene Type G-902 is the best wide fit. Thus, based on the scrubbing ability and the heterosis, half and half of them can be used in further reproduction procedures.

Shehzad *et al.* (2015) evaluated the study of the genetic and integration capabilities of the three major European oil painting analysts "Legend, Durre-NIFA and Punjab Salson", the five-line "Duncled, ZN-R-1, K-258, ZN-M-6 and ZN -R-8 "crossed with a line x analyzer. For most of the attributes, genotype changes are very large. The line "Duncled" is a general combination of corrosive, oily proteins, glucosinolates and oleic acid corrosive on different lines. The analyzer "Durree-NIFA" is used for corrosive, corrosive and protein The For most extreme proteins and minimal thioglucoside material, Legend + ZN-M-6 best half and half mixture, Legend × ZN-R-1 for oil and Punjab Sarson × Duncled for minimal corrosiveness and Linolenic acid corrosive substances, the largest oil material found in "Legend × ZN-R-1". Cross 'Duncled × Punjab Salson' proves the maximum estimate of the protein, but has the least impact on corrosive, linolenic acid and thioglucoside.

Shehzad *et al.* (2015b) led an experiment to evaluate heterosis. RCBD tests were performed on Line X Tester mating schemes for three analyzers and five lines. Choose fifteen qualities to record live information. The estimate of silicone length (14.3%, 11.1%) and seed yield / plant (45.3%, 35.9%) was high. The highest protein substance (26.5%) was recorded from the cross 13. In the comparison of hybridization advantages, the commercial heterosis of this intersection (Punjab Sarson × Duncled) shows the most notable heterosis. In order to change the quality and quantity parameters, a clear measurement of half rape rapeseed was selected.

2. Conclusion

Combining ability as a considerable analysis tool is not only useful for selecting favourable parents but also provides information concerning the nature of and importance of gene effects influencing quantitative traits. Reliable and precise prediction techniques of heterosis contributed in accelerating the crossbreeding and reducing the cost of large-scale field evaluation.

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