GENETIC PARAMETERS FOR MORPHOLOGICAL, PHYSIOLOGICAL AND YIELD ATTRIBUTES RELATED TO MOISTURE STRESS TOLERANCE IN GROUNDNUT - A REVIEW


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ABSTRACT

The success of any breeding programme depends upon the amount of variability present for different characters in a population and its efficient management. The genetic coefficient of variation is a useful measure of the magnitude of genetic variance present in the population. However, estimation of genetic variability alone cannot indicate the possible improvement that could be achieved through selection, but it should be used in conjunction with heritability and genetic advance. High heritability combined with high GAM was observed for most of the characters especially for shelling percentage, sound mature kernel weight and pod yield per plant. High heritability coupled with moderate genetic advance as percent of mean (GAM) was recorded for protein and sound mature kernel weight. Oil content showed high heritability with low GAM. It was also observed that variability and heritability for chlorophyll content and yield in 40 peanut genotypes and reported wide variability and moderate heritability values for chlorophyll content and seed weight per plant. High GCV, PCV and heritability and genetic advance were noticed for harvest index and its component traits viz., pod yield per plant, number of branches per plant and sound mature kernel percentage.

Key words: Genetic parameters, Morphological, Physiological, Yield attributes, Moisture stress, Groundnut.

Groundnut is an important oilseed crop grown in India and is largely cultivated as a rain-fed crop in dry lands. Drought is the most important factor limiting the yield potential of the rain-fed crop. Although high yield potential is the target of most crop breeding programs, it might not be compatible with superior drought resistance. On the other hand, high yield potential can contribute to yield in moderate stress environments. As conventional breeding and biotechnology make headways into the development of drought resistant cultivars, the conceptual framework of what actually constitutes a viable target for selection. Crop physiologists have identified number of traits that would help the breeder in development and identification of moisture stress tolerant genotypes with high yield potential. The present study is aimed at evaluating the genetic parameters for yield and yield attributes and moisture stress tolerance for efficient selection in segregating generations.

The degree of success depends upon the magnitude of heritability \( h^2 \) as it measures the relative amount of the heritable portion of variability. Genetic advance (GA) under selection gives an idea about how much of genetic gain obtained was due to selection. Hence, the estimates of genetic variability, heritability and genetic advance have an immense value in making decisions about the selection methods to be employed to bring about improvement in the desirable traits and yield in identifying the superior genotypes. Productivity of a crop species is the sum total effect of many biochemical, physiological, genetical and morphological traits of the plant. Donald (1968) suggested breeding for yield improvement in a particular type of environment by selection for physiological and morphological traits thought to be conducive to high yield in that environment. Duncan et al. (1978) and Wells et al. (1991) evaluated physiological changes which resulted in higher yields in groundnut cultivars released in USA. Nageswara Rao (1992) analyzed groundnut production in terms of physiological traits like WUE, photosynthesis and stated that very little progress has been made in identification and exploitation of genetic and physiological traits contributing to yield.
potential and adaptation. Too often traits are advocated based on theory and there are few attempts to study genetic variability and even fewer to establish their genetic control, heritability, variability and genetic advance as per cent of mean.

Superior genotypes can be isolated by selection if considerable genetic variation exists within the population. Besides genetic variability, heritability and genetic advance also plays a vital role in the improvement of any character. The progress in breeding for the economic traits, which are mostly polygenically controlled and environmentally influenced, is determined by the nature and magnitude of their genotypic variability. Hence, it is essential to partition the overall variability into heritable and non-heritable components with the help of genetic parameters like GCV and PCV, heritability and genetic advance. The magnitude of heritability on one hand and nature and extent of variability on the other hand give an idea for effective genetic improvement through selection.

Genetic variability, heritability and genetic advance

Kulkarni and Albuquerque (1967) reported that heritability was high the number of branches, number of developed pods and total number of pods but genetic advance was more for number of developed pods only. Basu and Ashokaraj (1969) estimated high heritability for the number of days to flowering, number of leaves per main stem, pods per plant and 100-pod weight. Majumdar et al. (1969) reported a wide range of phenotypic coefficient of variation for characters viz., number of mature pods per plant, shelling percent and pod yield per plant. They also observed moderate estimates of broad sense heritability for shelling percentage and low for number of mature pods per plant and pod yield.

Dixit et al. (1970) studied genotypic and phenotypic variability of 108 varieties of groundnut and reported wide variation in all character except in number of primary branches. High heritability was observed for characters like 100-seed weight and 100-pod weight which was accompanied by high genetic gain. Genetic advance was high for dry weight of mature pods per plant. Studies of Gupton and Emery (1970) on 108 groundnut varieties showed a wide variation for several characters and recorded 84.5 per cent heritability for number of primary branches and 77.5 per cent for number of mature pods. Khangura and Sandhu (1973) reported that genotypic coefficients of variation were high for pod yield and number of mature pods but low for shelling percentage.

Kushwaha and Tawar (1973) investigated on 36 Indian and 4 African varieties of groundnut and their studies revealed lowest phenotypic and genotypic variances for number of primaries. They were high for stem height, 100-pod weight and pod yield per plant. Expected genetic advance ranged from 0.42 for the number of primary branches to 9.26 for stem height. The studies on heritability estimates of some quantitative characters in F2 population of J11 x Gujarat Narrow Leaf Mutant cross by Balaiah and Reddy (1975) showed a high range of heritability (71.7 to 95.1 %) for number of mature pods per plant and pod yield per plant. The high heritability estimates along with moderate to high coefficients of variability for above character indicated that selection for number of mature pods and pod yield in the early segregating generations will be effective.

Kassam et al. (1975) reported that the slow early growth of groundnut was found to be due to the slow development of LAI. They also reported that LAI reached high values up to 5.5 to 7.0 and a large leaf area was normally maintained until just before maturity. Patra (1975) studied variability in 35 groundnut crosses and reported high broad sense heritability estimates and expected genetic gain for yield per plant indicating substantial additive gene action. Sandhu and Khehra (1976) reported high broad sense heritability for number of mature pods and pod yield in their study on crosses C-501 x Ah-6595 and C-501 x AK-12-24 in early generations. Williams et al. (1976) reported that maintenance of high LAI during pod filling period is important since sinks seemed to be not limiting. Maintenance of high LAI is advantageous especially in kharif season due to low photosynthetic rate under low light conditions. Sandhu and Khehra (1977) determined heritability and genetic advance in the F2 progenies of 2 peanut crosses for resistance to leaf spot, pod yield, 100-kernel weight, oil and protein contents. Broad sense estimates of
heritability were high for all traits except yield in both crosses. The estimated advance from selection was only high for resistance to late leaf spot.

Natarajan et al. (1978) evaluated thirty bunch groundnut varieties for genetic parameters. They recorded maximum GCV and PCV for number of pods per plant. Variability studies in semi spreading groundnut varieties by Dorairaj (1979) revealed that pod yield showed high heritability estimates combined with high genetic advance. Labana et al. (1980) observed high heritability and genetic advance for 100-kernel weight and number of secondary branches. Hari Singh et al. (1982) from studies on genetic variability and heritability for morpho-physiological attributes in groundnut reported significant difference among genotypes and high range of variability for biological yield, number of undeveloped pods, harvest index, number of pods per plant and pod yield. The differences between phenotypic and genotypic variances were high for biological yield. Harvest index and pod yield had low heritability values, while shelling percentage and number of undeveloped pods showed high heritability values.

Investigations on Spanish and Valencia groups of groundnut by Nagabhushanam et al. (1982) revealed that genetic advance was high for number of mature pods and moderate for pod yield. Heritability was high for number of primary branches, days to flowering, number of mature pods, shelling percentage, harvest index and pod yield. Quadri and Khunti (1982) studied quantitative characters in 24 peanut genotypes and reported high genotypic variation for harvest index pod yield and number of pods per plant while it was low for shelling percentage, number of primary branches and days to maturity. Chiow and Wynne (1983) reported substantial genetic variability for yield in advanced generations of a cross between an early maturing Spanish and a large fruited Virginia type.

Sandhu and Khehra (1983) studied $F_1$, $F_2$, $F_3$ and backcrosses and reported that epistatic variance is the major component in inheritance of leaflet length and width. Xiang et al. (1984) reported high heritability for the total number of branches in study of an incomplete diallel of four Spanish and four Valencia and suggested that it could be used as indirect selection criteria for yield in early generations. Chauhan and Shukla (1985) noticed high GCV for pod yield per plant in both bunch and spreading types. High heritability was recorded for pod yield, mature pods, days to maturity and pods per plant and low heritability for shelling percentage and harvest index in bunch group and number of primary branches in spreading types. Alam et al. (1985) reported high GCV for number of secondary branches and number of pods per plant. They also showed that secondary branches per plant, plant height, number of pods per plant and 100-kernel weight exhibited moderate heritability values and high genetic advance.

Basu et al. (1986) in an 8 parent diallel involving different habit group reported narrow sense heritability of 31.68% for number of mature pods per plant and 59.75% for pod yield per plant. Bhagat et al. (1986) observed high heritability and genetic advance for pod yield per plant and shelling percentage. Deshmukh et al. (1986) studied 22 Virginia bunch varieties of groundnut and concluded that PCV was higher than GCV for most of the characters studied but the difference was narrow for shelling percentage. Kandaswami et al. (1986) reported high heritability for plant height, number of primary branches per plant while number of mature pods, shelling percentage, harvest index and pod yield showed moderate heritability and genetic advance. Quijada and Layrisse (1986) in their inheritance studies reported that broad sense heritability estimates were high for number of primary branches and for branching type. Reddi et al. (1986) conducted studies on variability, heritability and genetic advance in Virginia cultivars of groundnut. They observed considerable amount of phenotypic and genotypic variability for number of primary branches. They obtained low heritability values for harvest index and pod yield and concluded that these traits were under the influence of environmental factors.

Oil content expressed low estimates of GCV, heritability and GAM (Nadaf and Habib, 1989). Reddy et al. (1987) in 6x6 diallel study of groundnut observed high heritability and genetic advance for the kernel yield and pod yield whereas shelling
percentage had high heritability and moderate genetic advance. Wang et al. (1987) recorded low heritability estimates for pod number per plant, number of filled pods per plant and yield per plant. Similarly Patil and Bhapkar (1987) reported a wide range of variation for pod number and pod yield. Swamy Rao et al. (1988) reported that number of primary branches exhibited high variability, heritability and GAM whereas pod yield showed moderate variability coupled with low heritability and GAM.

Manoharan et al. (1990) reported the highest phenotypic co-efficient of variation for pod yield per plant followed by pod number. Low heritability was reported for pod number, shelling percentage and pod yield per plant. Though genetic advance for pod yield per plant and pod number was high yet they had poor heritability values indicating that they are controlled by non-additive gene action. Manoharan et al. (1990a) recorded high heritability combined with high genetic advance for pod weight, dry matter production and kernel weight in F₂ population of J11x Chico. Further, dry matter production exhibited highest (47.8%) genotypic coefficient of variation. Dry matter production, pod weight and pod yield were highly heritable.

Manoharan et al. (1990b) in a study of 21 F₁s reported the highest phenotypic coefficient of variation and genotypic coefficient of variation for pod yield per plant followed by pod number. Low heritability was recorded for pod number, shelling per cent and pod yield per plant. Though, genetic advance for pod yield per plant and pod number was also high they had poor heritability values indicating that they are controlled by non-additive gene action. Prashanti et al. (1990) reported high variability coupled with high heritability and genetic advance for kernel yield and pod yield per plant. Vaddoria and Patel (1990) reported high estimates of genetic parameters for 100-seed weight, harvest index and number of mature pods. Number of primary branches exhibited low heritability.

Rami Reddy (1991) obtained higher PCV and GCV values for number of immature and mature pods per plant and pod yield per plant. Number of immature pods per plant showed low heritability. Shelling percentage had low genetic advance and heritability. Days to flowering recorded moderate PCV and GCV values. Bansal et al. (1992) observed high genetic variation and heritability for pod yield, kernel yield where as Mishra and Yadav (1992) reported high GCV, heritability and genetic advance for dry pod yield, kernel yield and plant height.

Patra et al. (1992) while studying genetic variation in advanced generations of groundnut reported high phenotypic coefficient of variation for number of mature pods per plant, harvest index, shelling per cent and pod yield per plant. Reddy and Gupta (1992) recorded high variability and genetic advance for pod yield, number of mature pods, shelling out-turn and harvest index. Manoharan and Ramalingam (1993) reported higher heritability but low genetic advance for kernel weight, days to 50 per cent flowering and shelling per cent. Number of primary branches recorded lower heritability. Pod yield showed highest genetic advance. Chavan and Dhoble (1994) while studying genetic variation in groundnut under water stress and natural conditions reported high genotypic coefficient of variation for number of mature pods per plant and moderate heritability for pod yield per plant(<65%) and number of mature pods per plant.

Ganeshan and Sudhakar (1995) reported higher genetic variability coupled with high heritability and genetic advance for primary branches. Pod yield per plant showed moderate values of variability but higher heritability coupled with high genetic advance. Mature pods per plant showed moderate values of GCV, heritability and genetic advance.

Nisar Ahamed (1995) reported that in parents, heritability, genotypic and phenotypic coefficients were moderate to high for characters like pod yield per plant, kernel yield per plant and shelling percentage. But they were low to moderate in crosses. Sumathi and Ramanathan (1995a) in 30 selected lines from F₂ generation of 5 crosses reported high heritability estimates for number of mature pods (57.6%), pod yield (57.7%) and shelling out-turn (56.6%). Sharma and Varshney (1995) noticed high GCV, PCV and heritability and genetic advance for harvest index and its component traits viz., pod yield
per plant, number of branches per plant and sound mature kernel percentage.

Bhat (1996) studied $S_1$ and $S_2$ generations of single and multiple crosses reported high heritability and genetic gain for percentage of green leaf area at the time of harvest and concluded early generation selection would be effective. Gowda et al. (1996) studied the variability and association of late leaf spot resistance and productivity in two crosses of groundnut and reported high variability. Varman and Raveendran (1996) in $F_2$ population of 6 crosses observed high heritability for number of mature pods per plant (59.6%), pod yield per plant (55.3%) and oil per cent (81.4%) They also revealed high heritability and low genetic advance for oil per cent indicating contribution of non-additive gene action. High heritability and high genetic advance for pod yield per plant and number of mature pods per plant indicate role of additive gene action in the inheritance of these characters.

Varman and Raveendran (1996) observed high heritability for plant height, number of mature pods per plant, number of pegs per plant and 100-kernel weight. Harvest index had low genetic advance. Shelling out-turn showed low heritability. Jayalakshmi (1997) among morphological and physiological attributes studied at population level, high genotypic coefficient of variation and heritability observed for harvest index and root dry mass in segregating generations. Despite low genetic variance specific leaf area and oil per cent exhibited high heritability values. Yield and yield attributes exhibited high heritability in $F_3$ generation.

Khurram et al. (1998) estimated variability, broad sense heritability and genetic advance in groundnut. High phenotypic and genotypic variances were recorded for pod weight per plant. High GCV, PCV were recorded for kernel yield per plant, pod weight per plant and number of primary branches. Heritability was high for number of days to flowering. High genetic advance and heritability for pod weight per plant indicated that additive gene effects were more important for this trait which offers scope for its improvement through mass selection.

Rudraswamy et al. (1999) in parents, $F_1$, $F_2$ and $F_3$ generations of six crosses of groundnut observed moderate genetic advance and high heritability for number of immature pods, pod yield per plant and shelling percentage. Singh and Singh (1999) also reported high heritability values for pod yield per plant and shelling percentage. Singh and Singh (1999b) observed high heritability for plant height, primary branches, pod yield per plant, shelling per cent and 100-kernel weight.

Misra et al. (2000) reported high GCV for pod weight per plant, 100-kernel weight and plant height suggesting that selection for these characters would be more effective. GCV was low for number of primaries per plant, number of pods per plant, shelling percentage and sound mature kernel percentage. High heritability was observed for 100-kernel weight and number of primary branches indicating that they were least influenced by environment. Medium heritability values were observed for plant height and pod weight per plant. The genetic advance as per cent of mean was high for pod weight per plant and 100-kernel weight, so phenotypic selection for the improvement of these characters would be effective.

Naik et al. (2000) estimated high GCV for pod weight per plant, 100-kernel weight and plant height suggesting that selection for these characters would be more effective. In their study, GCV was found to be low for number of primaries per plant, number of pods per plant, shelling percentage and sound mature kernel percentage. High heritability for 100-kernel weight and number of primary branches was recorded. They also recorded moderate heritability values for plant height and pod weight per plant and high genetic advance as percentage of mean for pod weight per plant and 100-kernel weight. Parmar et al (2000) also reported moderate to high narrow sense heritability for shelling percentage and pod yield while low estimates for percentage of mature seeds. Similarly Sharma and Varshney (1995) noticed high GCV, PCV, heritability and genetic advance for harvest index, pod yield per plant and sound mature kernel per cent. Rostini et al. (2000) studied variability and heritability for chlorophyll content and yield in 40 peanut genotypes and reported wide variability and moderate heritability values for chlorophyll content (estimated from chlorophyll meter minolta SPAD 502), seed weight per plant.

Vasanthi and Raja Reddy (2002) in their study in five $F_2$ populations reported high heritability
for shell thickness. Moderate to high heritability coupled with moderate to high genetic advance was reported for pod and kernel yields per plant. Vijayasekhar (2002) reported high GCV, PCV, heritability and genetic advance as per cent of mean for harvest index, 100-seed weight and shelling percentage. Low estimates of heritability, variability and genetic advance were observed for primary branches per plant, plant height, pods per plant and number of mature pods per plant. Bindu Madhava et al. (2003) observed significant genetic variation for SCMR (SPAD chlorophyll meter reading) and specific leaf area among three non nodulating lines in groundnut.

Makhan Lal et al. (2003) reported high GCV for root length. High gcv and pcv were also observed for number of mature pods per plant and pod yield per plant. Low heritability was noticed for pod yield per plant (20%), root length (41.7%) and number of mature pods per plant (40%). Low estimates of genetic advance for root length (1.77), number of mature pods per plant (4.38) and pod yield per plant (6.95) were observed. Vasanthi et al. (2003) from their studies on heritability, observed moderate heritability, GCV,PCV and genetic advance for SCMR, mature pods per plant, primaries and secondary branches per plant, weight of the plant, pod weight per plant and immature pods per plant. They also reported that the traits that conferred water use efficiency, high SCMR and low SLA showed moderate to high heritability and moderate to low GAM. They inferred that there was more scope for bringing improvement in SCMR through phenotypic selection than in SLA. Golakia et al. (2005) observed high PCV and GCV for kernel weight per plant, 100-kernel weight, harvest index and pod yield per plant. John et al. (2005) reported high estimates of GCV and PCV values for pod yield per plant indicating the presence of considerable amount of genetic variability for this character. High heritability coupled with high genetic advance as per cent of mean was observed for pod yield per plant indicating additive genetic variance for this character. Moderate and low genetic advance were observed for days to maturity and shelling out-turn indicating non additive gene action.

Ravi Kumar (2005) reported high GCV and PCV values for pod yield per plant, mature pods per plant and 100- seed weight. Moderate coefficients of variation were obtained for harvest index, plant height while low coefficients of variations were observed for shelling percentage, days to 50% flowering, primary branches per plant and SCMR.
High heritability estimates were observed for 100-seed weight, shelling percentage, harvest index, SCMR, plant height, primary branches per plant and mature pods per plant. Genetic advance as per cent of mean was high for 100-seed weight, mature pods per plant, harvest index and plant height while moderate GAM was recorded for shelling percentage, days to 50% flowering, primary branches per plant and SCMR.

Venkateswarlu (2007) observed high GCV and PCV for specific leaf nitrogen suggesting that selection for this would facilitate the successful isolation of drought tolerant genotypes. High heritability coupled with high genetic advance as per cent of mean were observed for specific leaf area, specific leaf nitrogen, sound mature kernel per cent and harvest index. Injeti et al. (2008) studied 164 genotypes (139 accessions and 25 advanced breeding lines) and reported that estimates of PCV and GCV were moderate for plant height, mature pods per plant, pod yield per plant, kernel yield per plant, shelling percentage, 100-kernel weight, harvest index and specific leaf area.

John et al. (2008) reported high GCV and PCV values for number of secondary branches per plant, pod yield per plant and kernel yield per plant. Moderate GCV and PCV were observed for shelling out-turn and 100-kernel weight, low values of GCV and PCV were recorded for days to initial flowering, days to maturity, number of primary branches per plant and SPAD chlorophyll meter reading.

John et al. (2008) reported high estimates of GCV and PCV, heritability and genetic advance as per cent of mean for plant height, secondary branches per plant, number of mature pods per plant, kernel yield per plant, haulms yield per plant and harvest index among F2 population of six single crosses. John et al. (2009) reported high heritability and high genetic advance as per cent of mean for number of secondary branches per plant, shelling percentage, 100-kernel weight, sound mature kernel weight, total number of pods and pod yield.

Sumathi and Muralidharan (2009) reported that sound mature kernel weight and pod yield per plant recorded high GCV and PCV estimates. High heritability was recorded for sound mature kernel weight. High heritability combined with high GAM was observed for shelling percentage, sound mature kernel weight and pod yield per plant. High heritability coupled with moderate GAM was recorded for protein and sound mature kernel weight. Oil content showed high heritability with low GAM.

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