REVIEW OF LITERATURE

Inheritance of some polygenic characters in cabbage connected with vegetable yield have been studied by various workers in the past. As far as the seed characters are concerned, no report is available in the literature on these lines. However, whatever limited work done by previous workers has been briefly reviewed as under:

Maturity

Pearson (1931) observed that earliness in cabbage is partly dependent upon genetic factors and partly on hybridization with resultant increase in vigour which may or may not necessarily be accompanied by earliness in maturity. Lingunova (1963) reported that hybrids between cabbage varieties were often intermediate between the parents in morphological characters and earliness, though they usually approached the seed parent. However, a number of combinations between early lines showed heterosis for earliness. Popov (1963) also found hybrids to be intermediate in maturity approaching the seed parent and some showed heterosis. According to Rasmussen (1932) in the crosses between early and late maturing varieties, the first generation was near the early parent. Mieuwhof (1963b) noticed that earliness in head maturity resulted from a more rapid head formation and the increased vigour was associated with increase in head weight. Timofeev (1946) reported that relationship existed between the length of vegetative period and quality of the head. The heads in very early varieties
were mostly small, light and greenish, while in late varieties they were always large, solid and white in colour. Smelina (1965) noticed a hybrid in white heading cabbage to be a week earlier than its female parent and was resistant to stalk break. Nieuwhof (1958) crossed the plants selected for earliness and the parents giving early F_1 hybrids were vegetatively maintained for continued production of the F_1 seeds. Feduleva (1957, 1958) found in the crosses of early and mid-early varieties, the F_1's to be mostly intermediate in maturity but excelled the parents in yield. Similar observations were made by Dorofov (1963) and Kitaeva (1968).

**Head shape**

The cabbage heads can be classified into three categories, flat, round and pointed. Intermediate shapes are also not uncommon. Pearson (1934) found that the head shape, in general, is controlled by many factors of no definite dominance. There was slight evidence that certain head factors are complementary to each other since one group of crosses produced flatter heads than the parents. He divided the width of the head by length and worked out shape index which varied from 0.9 (long) to 1.37 (flat). According to Dickson and Carruth (1967), the head shape segregation in F_2 followed the pattern of normal curve. He observed the heritability estimates of h^2 = 0.51 for head shape. Flory (1951) concluded that shape of the head is influenced both by genetical and environmental factors. Detjen and McCue (1933), Magruder (1937), advocated that many genetical
factors are involved in determining the shape of the head, Popova (1930) while selecting the head for the shape characters, observed that the round types appeared in a large proportion in comparison to flat types which were gradually disappearing. Tschermak (1916) reported the dominance of pointed head over round.

**Number of non-wraper leaves**

According to Boswell (1934), the number of non-wraper leaves varied from 11 to 28 depending upon the variety. The condition with the few leaves was dominant to that of more leaves. Pearson (1934) reported that this character is polygenically inherited. He succeeded in isolating inbred lines from cabbage variety Copenhagen Market in which the leaf number varied from 17 to 25. Swarup and Sharma (1965) observed the number of non-wraper leaves as a polygenic character. However, the heritability values and expected genetic advance for non-wraper leaves was low.

**Head size**

Rasmussen (1932) found in F1 progeny of the crosses of unrelated lines like smooth cabbage x savoy cabbage, plants having larger head size than both the parents. Pearson (1934) found that inbreeding may lead to depression in head size in some lines while he failed to observe it in other lines. Depression in head size was also reported by Kotowski (1926), Pearson (1933), Swan (1953), Poole (1953) also observed marked reduction in vegetative vigour after three seasons of inbreeding.
Warren and William (1936) reported weight of the head to be very variable character and is much influenced by the environmental changes. The inheritance of head size was studied in the crosses between cabbage and kale by Pease (1926), cabbage and kitchen kale by Allgayer (1928), tight headed cabbage and loose headed savoy by Rasmusson (1932). Several other workers have also reported the size of head to be a polygenic character (Sutton, 1908; Taschermak, 1916; Harvey, 1923; Kristofferson, 1924; Betjen, 1926; Pease, 1926; Allgayer, 1928; Malinowski, 1929; Sampson, 1930; and Betjen and Meuse, 1933). Lisgunova (1963) found that when the parents differed widely in head size, the F₁ hybrids usually had bigger head size than the smaller parent. They had, however, smaller heads when compared with the larger parent. Uniformity in head size and head maturity has been observed by Hastings (1950), Adamson (1957) and Koralev (1964) to be of great advantage. Gizatova (1965) observed heterosis for head size and yield. Voipio (1966) noticed that hybrids produced larger heads but also showed higher losses in storage.

**Compactness**

The inheritance of the compactness of head is a polygenic character as reported by Rasmusson (1932) from his study of a cross between tight headed cabbage and loose headed savoy type. Swarup and Sharma (1965) also observed compactness to be a polygenically inherited trait. They obtained high heritability value and genetic gain for the compactness of the head. Krickl (1942; 1950; 1955) noticed that short stalk was
closely associated with the size and compactness of the head. Giszatova (1963) observed that most of the hybrids had greater compactness of the head than the parents.

**Core length**

The core length was influenced by many factors. Dickson and Carruth (1967), reported that inheritance of core length was dependent on two major genes each partially dominant for short core length. Short core was related with the round heads and vice versa. However, Pearson (1934) did not observe any dominance in the inheritance of the penetration of the core into the head. Hybrids between long and short cored strains were intermediate in core length.

**Seed size**

Laux (1953) studied the effect of seed size on vegetative vigour and rate of growth of the young plants. Seed size was found to be influenced largely by weather and other environmental factors. He advocated that seed size is a inherited character but failed to establish significant relationship between mother plant and that of its progeny. He, however, suggested the development of large population of identical plants by vegetative propagation which could then be grown under different environments for establishing the comparative influence of heredity and environment.

**Seed yield**

Dorohev (1963) obtained high seed yield from the hybrids produced by planting two varieties in alternate rows. The
resultant plants were more resistant to diseases and unfavourable growing conditions. Anohina (1969) also obtained high seed yield from the $F_1$ hybrids which varied from 67-89 gms per plant.

Detjen and McCue (1933) found pod length to be a hereditary character and controlled by multiple factors. He also reported that early character which initiate flower stalk formation before ordinary rest period, fascination of core, wavy leaf margin, leaf proliferation and savoy leaves were also found to be hereditary and was due to multiple factor action. Magruder and Myers (1933) studied the inheritance of plant colours and suggested the genetic formula, $S M$ for purple, $sM$ for magenta, $Sm$ for sun colour and $sm$ for green colour. Miller (1929) studied some factors affecting seed stalk development in cabbage. Lingunova (1963) observed that hybrids had reduced tendency towards bolting. Magruder (1937) stated that most of the commercially important characters in cabbage are quantitative in inheritance. Yarnell (1936) has reviewed the cytological work done in cabbage.

Heterosis

The investigations of Pearson (1931), Khimic (1935), Koloberdina (1941) and Pavlov (1941) revealed heterosis in size, weight and compactness of the head, rate of growth and yield. Parents which were unrelated and complementary with regard to growth rhythm and development invariably produced superior hybrids.
Heterosis in vegetable yield have also been observed by various other workers (Nayres, 1942; Evgenjev, 1948; Attia and Munger, 1950; Odland and Noll, 1950; Odland and Isenberg, 1950; North and Squibbs, 1952; Woods, 1953; Nieuwhof, 1958; Parlova and Novikov, 1960; Breznev, 1961, 1964; Nieuwhof, 1963b; Dorehov, 1963; Polianskij, 1963; Minkov, 1963; Swarup and Gill, 1964). Pepeva (1963) produced hybrid seeds by planting alternate rows of two parents. He observed maximum heterosis for yield when the parents differed in morphological and other features. Similar results were obtained by Lzigunova (1963). The hybrids suitable for arid zones have been produced by crossing varieties differing in maturity time and geographical origin. Swarup et al. (1963) and Swarup and Sharma (1965) took up detailed genetical studies and found that maturity, net weight of the head, number of marketable heads, were influenced by dominance with greater frequency of dominant alleles. Yield showed over dominance with pre-dominance of recessive alleles in the parents. Complementary epistasis was present in all the characters except maturity which had pronounced additive effects. However, in their latter study (Swarup and Sharma, 1965), low additive gene effects in all characters except head shape index were observed. Moreover, they all exhibited duplicate epistasis. Plot yield and net weight of head were influenced by high additive x additive interaction. Chiang (1969) found that additivity for inheritance of inner core and days to maturity appeared to be important. Equal importance of additivity and dominance was observed in
polar and equitorial diameter. Dominance controlled large portion of the genetic variation in yield while number of non-wraper leaves varied with environment. The effective factors controlling each character ranged from one to three. The heretability values were high for polar diameter and days to maturity, moderate for number of non-wraper leaves, length of inner core and low for equitorial diameter and yield.

**Correlations**

Sharma and Swarup (1964) while studying the genotypic and phenotypic correlation coefficients found maturity to be positively correlated phenotypically with net weight and shape of head and negatively with compactness, whereas compactness was negatively correlated with head shape index phenotypically. The gross weight of head was positively correlated with net weight and number of non-wraper leaves and negatively with shape of the head index both phenotypically and genotypically. Negative phenotypic correlations were observed between net weight of the head and shape index as well as number of non-wraper leaves. There was no significant correlation observed between shape index and number of non-wraper leaves. Som (1962) worked out phenotypic and genotypic correlation coefficients in cabbage and observed that genotypic correlations were higher than the phenotypic. The gross and net weight of the head, compactness of the head, maturity and number of marketable heads were found to be positively correlated with yield. The gross weight of head was positively correlated with number of
non-wrapped leaves, on the other hand, it did not show any relationship with number of marketable heads. Yield, net weight, compactness, maturity and number of marketable heads were correlated with each other except maturity, which did not show any relationship with number of marketable heads. Poljanskij (1963) established a correlation between yield of the hybrids and their leaf area and number. Dickson and Carruth (1967) observed positive correlation between short core and round heads, indicating association between these two characters. Nieuwhof (1969) reported negative correlation between earliness and productivity and between keeping quality and productivity.

Oleiferae Brassicae

As no report is available on seed characters of cabbage, some work done in these crops which may have some bearing on the present problem has, therefore, been briefly reviewed.

Mohammad et al. (1931) reported that yield per plant in Brassica campestris var. toria was more or less positively correlated with number of primary branches, length of pod and 1000-seed weight. Sun (1937) observed significant positive correlation between height of the plant, number of inflorescence and yield per plant in rape on two years observations. Stolle (1954) working with winter rape noticed high positive correlation between number of pods and yield per plant and between yield of seed and number of seeds per pod. Negative relationship was established between 1000-seed weight and number of seeds per pod. No relationship was found between number of pods and number of seeds per pod. Schimpf (1954) reported that correlation coefficient between number of pods and yield per
plant was as high as 0.90 and confirmed the results of Stolle (1954). Mann (1957) working with winter rape (*Brassica napus oleifera*) established correlation of plant density with plant height, stalk stiffness, 1000-seed weight and seed yield. Rives (1957) found significant correlation between number of seeds per pod and height of the plant. Morice (1960) made a statistical analysis of yield and its components. He observed existence of significant correlation between weight of the seeds per pod of the mother plant and average yield of the plot. Olsson (1960) studied relationship between number of seeds per pod, seed size and oil content in genus *Brassica* and *Sinapis*. He found that decrease in 1000-seed weight in white mustard tended to be associated with increase in number of seeds per pod and a significant negative correlation was detected between 1000-seed weight and oil content. Rai (1961) reported that association of yield was highest with number of pods per plant. Association between yield and number of primary and secondary branches was highly influenced by environment. Seed yield was also significantly correlated with time of flowering, number of primary branches, number of secondary branches, number of pods per plant, number of seeds per pod and 1000-seed weight in *Brassica campestris* var. *yellow sarson*. Ramanujam and Rai (1963) observed in yellow sarson the seed yield to be positively correlated with number of primary branches, number of secondary branches, number of pods per plant, number of seeds per pod and 1000-seed weight. Considering the yield components, one strong feature was the
fact that most of these characters were strongly and negatively correlated with each other which may be due to the competition for a limited supply of energy sources. The association between number of pods per plant and number of primary and secondary branches constituted sole exception to this generalization. Both path-coefficient analysis and correlation studies agreed in showing that it is difficult to combine high expression of basic components of yield. Maini et al. (1964) found significant positive correlation between seed yield, plant height, number of primary branches and days to flowering in *Brassica campestris* var. *toria*. Riemann (1964) working with rape observed correlation between seed yield and number of capsules. There was no significant relationship between capsule length and 1000-seed weight or oil content or between oil content and number of seeds per capsule. Capsule length was positively correlated with seed yield; whereas number of seeds per capsule was negatively correlated with 1000-seed weight. There was negative correlation between oil content and seed size, seed yield, 1000-seed weight and number of capsules per plant. Quadri et al. (1966) found the existence of strong inherent relationship between days to first flowering, number of primary branches, number of fruit bearing secondary branches, height at maturity, number of siliqua on the main axis and number of seeds per siliqua in self-compatible lines of *Brassica campestris* var. *brown sarson*. The large environmental correlation between secondary branches and primary branches, siliqua on the main axis with height, were
found to be the probable causes for limiting simultaneous improvement of these characters. Chaudhari (1967) worked out correlations between yield and yield contributing characters in *Brassica juncea*. Yield was highly correlated with number of pods per plant, number of secondary and number of primary branches. The genotypic correlations were generally lower. Most of the environmental correlations between yield and its attributing characters were themselves significant.