ANALYSIS OF MATURITY RELATED CHARACTERS AND IDENTIFICATION OF EARLY MATURING VARIETIES IN GROUNDNUT

BY

SUNIL KUMAR, A. C.

THESIS

submitted in partial fulfilment of the
requirement for the Degree of

MASTER OF SCIENCE IN AGRICULTURE

Faculty of Agriculture
Kerala Agricultural University

Department of Plant Breeding
COLLEGE OF AGRICULTURE
VELLAYANI, TRIVANDRUM

1990

To

my parents and brother

DECLARATION

I hereby declare that this thesis entitled "Analysis of maturity related characters and identification of early maturing varieties in groundnut" is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship, or other similar title of any other University or Society.

Vellayani,
14.2.1990.

Sunil Kumar, A.C.

CERTIFICATE

Certified that this thesis entitled "Analysis of maturity related characters and identification of early maturing varieties in groundnut" is a record of the research work done independently by Shri Sunil Kumar, A.C. under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to him.

Dr.SVERUP JOHN
Chairman
Advisory Committee
Associate Professor
N.D. Scheme (KAU)
Anandappally, Adoor.

Vellayani,
14.2.1990.

APPROVED BY:

CHAIRMAN:

Dr. SVERUP JOHN

MEMBERS:

1. Dr.V.GOPINATHAN NAIR

2. Dr.(Mrs) P. SARASWATHY

3. Dr.K. HARIKRISHNAN NAIR

EXTERNAL EXAMINER:

Dr. S.THANGAVELU
PROFESSOR AND HEAD
REGIONAL RESEARCH STATION
VRIDHACHALAM.

ACKNOWLEDGEMENT

In connection with the satisfying completion of the thesis, the author wishes to thank

Dr.Sverup John, Associate Professor of Plant Breeding, N.D. Scheme(KAU), Anandappally, Adoor and Chairman of the advisory committee, for his valuable guidance, constant encouragement and constructive criticism;

Dr.V.Gopinathan Nair, Professor and Head, Department of Plant Breeding, College of Agriculture, Vellayani, for his helpful suggestions;

Dr.(Mrs) P.Saraswathy, Professor and Head, Department of Statistics, College of Agriculture, Vellayani for her invaluable help in the experimental layout and statistical analysis;

Dr.K.Harikrishnan Nair, Associate Professor of Agricultural Chemistry, College of Agriculture, Vellayani, for critical study of the manuscript and helpful suggestions;

Shri S.Murali, one of his best friends and colleague, for his sincere and timely assistance;

his colleagues and the teaching and non-teaching staff of the Department of Plant Breeding, for their whole-hearted co-operation;

the Kerala Agricultural University for awarding the Post-graduate fellowship;

his parents and brother for their inspiration and sincere prayers, and

above all the Almighty for all the goodness showered on him.

Vellayani,
14.2.1990.

Sunil Kumar, A.C.

CONTENTS

LIST OF ILLUSTRATIONS

(contd.)

LIST OF TABLES

LIST OF ILLUSTRATIONS

(contd.)

LIST OF ILLUSTRATIONS (Contd.)

INTRODUCTION

INTRODUCTION

OILSEEDS occupy the most significant place in India's national economy next to food grains and accounts for about 10 per cent of the cultivated area and value of all agricultural produce. They form the raw materials for edible vegetable oils, and also for non-edible oils (as of castor, linseed etc.) which are used industrially for making soaps and cosmetics, besides being exported.

India is the third largest producer of oilseeds in the world. But the per capita consumption of edible oil is very low in India (5 kg) compared to the world average (11 kg). The major oilseed crops of India include groundnut, rapeseed-mustard, sesamum, linseed, castor, safflower, sunflower and niger. India ranks first in the production of groundnut and sesamum and second in both castor and rapeseed-mustard. Increase in population and improvement in standard of living of the people have resulted in faster rate of growth of demand of edible oils, leaving the supply behind. This is being compensated by the import of edible oils, which leads to considerable drain in foreign exchange reserves of the country . During the year 1983- '84, the import of edible oils shot upto 16.34 lakh tonnes worth Rupees 1319 crores. Achievement of self sufficiency in the production of oilseeds is now being taken up as a major need by the country and is the main programme envisaged by the National Oilseeds Development Project and Oilseed Technology Mission set up by the Government of India. Thus the need for evolving high yielding varieties of oilseed crops suited to local conditions assumes paramount importance.

The cultivated groundnut,(*Arachis hypogaea* L.) also known as peanut, monkeynut and goobernut is a native of South America, with Bolivian region as its primary centre of origin (Krapovickas, 1968). It is a tetraploid with n = 20, 2n = 40 (Kawakami, 1930). It belongs to the subtribe-Stylosanthineae, tribe-Hedysareae, subfamily-Papilionaceae, family-Leguminosae, genus-Arachis and species-hypogaea (Linn). It contains about 45-50 per cent fat and 25 per cent protein.

As an oilseed crop, groundnut alone comprises 55 per cent of the area and production of oilseeds in the country. It is presently cultivated in an area of 7.4 million hectares with a production of 6.5 million tonnes (Patel, 1988). The productivity per hectare for groundnut works out to 880 Kg, as against its production potential of over 2000 Kg/ha. Gujarat accounts for approximately 25 per cent of the area and production of the crop in India.

Groundnut is grown in our country as a pure crop in both kharif and rabi season. In South India, groundnut is mainly grown as an important oilseed crop under rainfed condition, providing protective irrigation at critical stages of its growth wherever possible. Groundnut also forms an integral part of multiple cropping and inter-cropping systems of cultivation practised in many states, mainly due to its high productive potentiality, wider adaptability, high market-value and short maturity period as compared to other crops.

Eventhough an energy-rich crop, groundnut is generally grown in India under energy-starved conditions. The low and stagnant productivity of groundnut in India may be attributed to

(i) seventy five per cent of the crop area lying in a low to moderate rainfall zone with a short period of distribution of rain,

(ii) the crop being grown mostly by small and marginal farmers in lands with low fertility and

(iii) poor agromanagement practices being adopted like low plant density, inadequate fertilisation and untimely plant protection measures.

In Kerala, although not considered as the chief source of edible oil, groundnut is highly valued for its rich protein content. It is cultivated in the State in an area of about 14,750 ha, with a production of about 13,900 tonnes (Anon, 1990). The average productivity of the crop in the State works out to 943 kg/ha. The low productivity of the crop in Kerala may also be attributed to the reasons mentioned earlier. In addition, the crop needs extensive cultivation in the State for increasing its production. The crop has great potential for large scale cultivation in Kerala, if it can be raised in the summer rice fallows, which can offer less than 100 days duration for a third crop, under the rice based cropping pattern traditionally adopted in the State. It is also a fact well understood from experience that a summer crop of groundnut raised under irrigated condition will give double the yield of a kharif crop. So also the production of groundnut in summer will have a stabilising influence on the price behaviour due to arrival of the produce in the market during off-season.

The need for high yielding, short duration or early maturing groundnut varieties thus assumes paramount importance in terms of optimum utilization of land and time, replenishment of soil fertility through nitrogen fixation, its inherent capacity to utilise the residual soil moisture and its ability to attain early maturity, thereby avoiding any possible incidence of drought. Hence the present study adopting staggered system of harvesting aimed at fulfilling the following precise objectives.

1) Analysis of maturity related component characters in groundnut in staggered harvests.

2) Determination of time of optimum maturity of the test genotypes.

3) Identification of early maturing genotypes.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Groundnut (*Arachis hypogaea* L.) is a crop of the New World, which was introduced into India during the late nineteenth century. Richter (1899) classified cultivated groundnut into two large botanical groups based on their branching pattern, viz., Virginia and Spanish-Valencia. The updated subspecies classification of *Arachis hypogaea* L. is presented below.

Arachis hypogaea Linn. (1753)
- subsp. *hypogaea* Krapovickas and Rigoni. (1960)
  - var. *hypogaea* (type VIRGINIA)Gregory et al.(1951)
  - var. *hirsuta* Kohler. (1898)
- subsp. *fastigiata* Waldron. (1919)
  - var. *fastigiata* (type VALENCIA) Gregory et al.(1951)
  - var. *vulgaris* (type SPANISH) Gregory et al (1951)

The Spanish-Valencia groundnut (*Arachis hypogaea* subsp. *fastigiata*) characterised by erect to decumbent habit, sequential branching pattern and the presence of simple or compound inflorescences always on the main axis, primary and secondary branches are suited for intensive cultivation due to their high productivity, and form the base material of the present study.

In order to identify early maturing groundnut genotypes it is required to determine their time of optimum maturity. However, the subterranean process of pod formation and the indeterminate habit characteristic of groundnut, along with soil and atmospheric factors make maturity determination difficult. However by adopting staggered system of harvesting, maturity related components can be analysed to determine the time of optimum maturity (Rao and Gibbons, 1984).

Works on maturity determination in groundnut are in the pioneering stages and hence literature in this line of study are limited. Available literature on the various maturity related components in groundnut are reviewed below.

2.1 Height of plant

Dwarf stature is monogenically recessive to tall (Hull, 1937 and Bhuiyan, 1984). Singh et al. (1971) however reported over dominance for inheritance of the above character and that excess of dominant genes was associated with it. Balaiah et al. (1984) suggested that genes controlling the character growth habit were linked with those controlling characters like branching pattern and number of primaries and secondaries.

Natarajan et al. (1978) observed low variability for the character plant height. It showed low genotypic coefficient of variation (Kulkarni and Albuquerque, 1967; Basu and Raj, 1969; Dixit et al., 1970; Patra, 1975 and Lakshmaiah, 1978). The parameter also showed low phenotypic coefficient of variation (Dixit et al., 1971; Patra, 1975; Lakshmaiah, 1978 and Deshmukh et al., 1986).

High heritability followed by moderate genetic advance was reported for plant height (Kulkarni and Albuquerque, 1967; Basu and Raj, 1969; Dixit et al.,1970; Raman and Rangaswamy, 1970; Kushwaha and Tawar, 1973 and Lakshmaiah, 1978). Sivasubramanian et al. (1977) obtained high heritability with high predicted genetic advance for this character. Patra (1975) however reported low heritability with moderate genetic advance for plant height.

The height of plant registered significant negative correlation with pod yield (Mahapatra, 1966; Lakshmaiah, 1978; Nagabhushanam, 1981 and Wu, 1983). On the other hand, Kushwaha and Tawar (1973) and Rao (1978/79) reported positive correlation between these two parameters. Bhargava et al. (1970) however observed no correlation between plant height and pod yield. Plant height also showed significant negative correlation with the number of mature pods per plant (Dorairaj, 1962; Lakshmaiah, 1978 and Nagabhushanam, 1981). However the character showed significant positive correlation with the number of primary branches and significant negative correlation with the number of secondary branches (Lakshmaiah, 1978 and Nagabhushanam,1981). The plant height showed positive association with the days to first flowering (Nagabhushanam, 1981). It showed significant positive correlation with 100 pod weight (Nigam et al., 1984), but significant negative association with 100 kernel weight and shelling percentage (Nagabhushanam, 1981).

2.2 Days to flower

Singh et al. (1971) reported average partial dominance for days to first flowering. He added that excess of dominant genes was associated with earliness in flowering.

The days to first flowering expressed only a narrow range of variation (Majumdar et al., 1970 and Qadri and Khunti, 1982). It showed strong positive correlation with pod yield (Rao, 1978/79 and Nagabhushanam, 1981), days to maturity, shelling percentage and number of pods per plant (Yadava et al., 1984). Nagabhushanam (1981) observed positive association of this character with number of mature pods per plant, number of secondary branches and 100 kernel weight.

2.3 Number of branches

2.3.1 Number of primary branches

Singh et al. (1971) reported over dominance for the inheritance of the number of primary branches. He added that excess of dominant genes was associated with the expression of this character. Balaiah et al. (1984) suggested linkage of this character with other characters like growth habit, branching pattern and number of secondaries.

The number of primary branches per plant exhibited low variability (Sangha and Sandhu, 1975, Natarajan et al., 1978 and Qadri and Khunti, 1982). However Majumdar et al. (1969) reported wide range of variation for this character.

The character expressed low genotypic and phenotypic coefficients of variation (Dixit et al., 1970; Sangha, 1973; Patra, 1975 and Lakshmaiah, 1978). However Kulkarni and Albuquerque (1967) and Majumdar et al.(1969) reported moderately high genotypic coefficient of variation for this character.

The character expressed very high heritability with low genetic advance (Kulkarni and Albuquerque, 1967; Dixit et al., 1970 and Raman and Rangaswamy, 1970). However, Majumdar et al.(1969) reported very high heritability with high genetic advance. Patra (1975), on the other hand observed low heritability with very high genetic advance for the number of primary branches.

The number of primary branches showed significant positive correlation with the pod yield (Bhargava et al. 1970; Dholoria et al., 1973; Nagabhushanam, 1981; Yadava et al., 1981 and Ibrahim, 1983). It also exhibited a similar association with the number of mature pods per plant (Sangha,1973 and Nagabhushanam, 1981). This character exhibited strong positive association with the number of secondary branches (Sangha, 1973; Lakshmaiah, 1978 and

Nagabhushanam, 1981). The character also showed significant positive association with 100 kernel weight and shelling percentage (Nagabhushanam, 1981).

2.3.2 Number of secondary branches

The number of secondary branches exhibited low genotypic coefficient of variation (Dixit et al., 1970 and Sangha, 1973) and fairly high phenotypic coefficient of variation (Dixit et al., 1971). However, Lakshmaiah (1978) reported high genotypic and phenotypic coefficients of variation for this character. It expressed high heritability with moderate genetic advance (Dixit et al., 1970; Sangha, 1973 and Lakshmaiah, 1978). However Raman and Rangaswamy (1970) reported high heritability with high genetic advance for this character. High heritability for the character was also reported by Sangha and Sandhu (1974) and Sandhu and Khehra (1975).

The number of secondary branches showed significant positive correlation with pod yield (Bhargava et al., 1970; Nagabhushanam, 1981 and Lakshmaiah et al., 1983). On the contrary, Sangha (1973) reported a significant negative correlation between these two parameters. The number of mature pods also showed strong positive association with the number of secondary branches. (Dorairaj, 1962 and Nagabhushanam, 1981). It showed strong negative correlation with the height of plant (Lakshmaiah, 1978 and Nagabhushanam, 1981). Nagabhushanam(1981) also reported significant positive association of this character with 100 kernel weight and shelling percentage.

2.4 Number of mature pods

The number of mature pods accounted for 85 per cent of the variation in pod yield (Ibrahim, 1983). It recorded fairly high genotypic coefficient of variation (Kulkarni and Albuquerque, 1967 and Dixit et al., 1970). However low values of the same were also reported for this character (Majumdar et al., 1969; Dixit et al., 1971; Sangha, 1973; Patra, 1975 and Lakshmaiah, 1978). Dixit et al.(1971) also reported very high phenotypic coefficient of variation for this character. However very low phenotypic coefficient of variation was also reported (Sangha, 1973; Lakshmaiah, 1978 and Deshmukh et al., 1986).

The number of mature pods recorded high heritability (Kulkarni and Albuquerque, 1967; Majumdar et al., 1969; Dixit et al., 1970; Sangha, 1973; Balaiah and Reddy, 1976;

Sandhu and Khehra, 1976; Sivasubramanian et al., 1977 and Lakshmaiah, 1978). However, very low heritability was also observed for this character (Sangha, 1973 and Patra, 1975). The character also showed moderate to high genetic advance (Majumdar et al., 1969 and Dixit et al., 1970). In addition it showed moderate to high genetic gain (Sangha, 1973; Patra, 1975 and Sivasubramanian et al., 1977). However low genetic advance for the trait have also been reported (Kulkarni and Albuquerque, 1967; Lakshmaiah, 1978 and Deshmukh et al., 1986).

The number of mature pods exhibited significant positive correlation with pod yield (Dorairaj, 1962; Mohan et al., 1967; Lin et al., 1969, Badwal and Singh, 1973; Kushwaha and Tawar, 1973; Sangha, 1973; Nagabhushanam, 1981; Ibrahim, 1983; Lakshamaih et al., 1983 and Deshmukh et al., 1986). Ibrahim (1983) added that the number of mature pods was the main component determining the ultimate pod yield in bunch groundnut. Badwal and Singh (1973) observed high negative correlation of this character with 100 kernel weight and strong positive correlation with shelling percentage. Positive, though non-significant, association between this parameter and the days to first flowering was reported by Nagabhushanam (1981). Number of maturepods had significant negative association with the height of plant (Dorairaj, 1962; Lakshmaiah, 1978 and Nagabhushanam, 1981). It registered significant positive correlation with the number of primary branches (Sangha, 1973 and Nagabhushanam, 1981). Dorairaj (1962) and Nagabhushanam (1981) reported significant positive association of this character with the number of secondary branches.

2.5 Pod yield

Pod yield in groundnut is a complex character governed by a large number of cumulative duplicate non-dominant genes that are quantitatively inherited (Dorairaj, 1962). Singh et al (1971) reported over-dominance for the inheritance of character pod yield. He opined that excess of dominant genes were associated with it.

Wide range of genotypic and phenotypic variation was reported for pod yield (Sangha and Sandhu 1975; Natarajan et al., 1978; Qadri and Khunti, 1982 and Nadaf et al., 1986). The character expressed low genotypic coefficient of variation (Basu and Raj, 1969; Majumdar et al., 1969; Dixit et al., 1971; Sangha, 1973 and Deshmukh et al., 1986). However moderately high genotypic coefficient of variation has also been reported (Dixit et al., 1970; Sangha and Sandhu, 1974; Patra, 1975; Lakshmaiah, 1978 and Qadri and Khunti, 1982). It also exhibited moderate to high phenotypic coefficient of variation (Dixit et al., 1971), Sangha and Sandhu 1974; Patra, 1975 and Qadri and Khunti, 1982).

Pod yield showed high heritability with high genetic advance, (Raman and Rangaswamy, 1970 and Patra, 1975). However, high heritability with low genetic advance for this character was also reported (Dixit et al., 1970; Lakshmaiah, 1978 and Natarajan et al., 1978). Sangha (1973) however reported fairly high heritability with moderate genetic advance. Moderate values of heritability with low genetic advance were also reported for this character (Basu and Raj, 1969; Majumdar et al., 1969 and Dixit et al., 1971). Low heritability has also been reported (Singh et al., 1971 and Sivasubramanian et al., 1977). Basu et al.(1986) obtained fairly high value of narrow sense heritability for this character.

Pod yield showed significant positive correlation with the number of mature pods per plant (Dorairaj, 1962; Mohan et al., 1967; Lin et al., 1969; Badwal and Singh, 1973;

Kushwaha and Tawar, 1973; Sangha, 1973; Nagabhushanam, 1981; Ibrahim, 1983; Lakshmaiah et al., 1983 and Deshmukh et al., 1986). Significant positive correlation between pod yield and 100 pod weight was reported by Deshmukh et al (1986). It also showed strong positive association with 100 kernel weight (Sangha, 1973; Rao, 1978/79; Nagabhushanam, 1981; Ibrahim, 1983; Kataria et al., 1984; Yadava et al., 1984 and Deshmukh et al., 1986). Deshmukh et al. (1986) reported significant positive correlation between pod yield and percentage of sound mature kernels. Pod yield also showed positive correlation with the shelling percentage (Ibrahim, 1983 and Kataria et al., 1984). It exhibited significant negative correlation with the plant height (Mahapatra, 1966; Lakshmaiah, 1978; Nagabhushanam, 1981 and Wu, 1983). On the contrary, Rao (1978/79) reported strong positive association between these two characters. However reports showing no correlation between pod yield and plant height are also available (Bhargava et al., 1970). Mohan et al. (1967) reported high positive correlation between pod yield and the haulm yield. Ibrahim (1983) observed that yield of haulms was very closely associated with pod yield and had high direct effect on it. The number of branches per plant showed significant positive correlation with the pod yield (Dholaria et al., 1973 and Ibrahim, 1983). Pod yield showed significant positive correlation with the number of primary branches (Bhargava et al. 1970; Nagabhushanam, 1981 and Yadava et al. 1981). Bhargava et al. (1970) also reported significant positive correlation of pod yield with the number of secondary branches. Studies conducted by Nagabhushanam (1981) and Lakshmaiah et al.(1983) support this view. However Sangha (1973) reported a significant negative correlation between pod yield and the number of secondary branches. Pod yield expressed a negative and non-significant correlation with the harvest index (Ibrahim, 1983). He further observed a negative association of this character with oil and protein content in the kernel. Rao (1978/79) and Nagabhushanam (1981) reported a strong positive correlation between pod yield and days to first flowering. On the otherhand it showed a negative correlation with the days to 50 per cent flowering (Deshmukh et al., 1986). Rao (1979b) reported positive significant correlation of pod yield with the number of flowers produced per plant. Wu (1983) reported pod yield to be negatively correlated with the days to maturity. However, Alam et al. (1985) observed positive correlation between the two traits. Choudhari (1985) reported that total dry matter showed a significant positive relationship with pod yield. However negative association between the two characters was also observed (Deshmukh et al., 1986). Pod yield was negatively correlated with resistance to Cercospora disease (Miller and Norden, 1980).

2.6 100 pod weight

Large pod size was dominant to small pod size and was monogenically inherited (Balaiah et al., 1977). However Cahaner (1978) reported that small pod character was dominant over large pod character was controlled by duplicate gene interaction. Natarajan et al. (1978) reported high phenotypic and genotypic variances for this character. Cahaner (1978) reported high heritability for this character The character expressed significant positive association with pod yield (Deshmukh et al., 1986). However it expressed negative, non-significant association with oil percentage (Kushwaha and Tawar, 1973).

2,7 100 kernel weight

Large kernel size was dominant to small kernel size and was controlled by a single factor, influenced by a complex of modifier genes (Hassan, 1964 and Balaiah et al., 1977).

Low phenotypic and genotypic variances was reported for 100 kernel weight (Sangha and Sandhu, 1975). However high values for this have also been reported (Natarajan et al., 1978 and Qadri and Khunti, 1982).

The 100 kernel weight exhibited high heritability with high genetic advance (Badwal and Gupta, 1968; Dixit et al., 1970; Sangha and Sandhu, 1975; Sandhu and Khehra, 1976; Kumar and Yadava, 1979; Rao, 1979; Singh et al.,1982 and Qadri and Khunti, 1982). Deshmukh et al. (1986) reported high heritability with moderate genetic advance. Basu et al. (1986) however recorded moderate heritability in narrow sense for the character. Low heritability values for this character have also been reported (Kandaswami et al., 1986).

The 100 kernel weight showed significant positive correlation with pod yield (Sangha, 1973; Rao 1978/79; Nagabhushanam 1981; Yadava et al. 1984 and Deshmukh et al., 1986). It showed significant negative correlation with number of mature pods per plant (Badwal and Singh, 1973). Nagabhushanam (1981) reported positive non-significant correlation of this character with days to first flowering. He added that it also exhibited significant negative correlation with the plant height and significant positive correlation with the number of primary and secondary branches.

2.8 Shelling percentage

The character shelling percentage was controlled by a single pair of genes without dominance (Martin, 1967). It showed low variability (Natarajan et al. 1978 and Qadri and Khunti, 1982). However Velu and Gopalakrishnan (1985) suggested high variability for this character. The character showed positive correlation with pod yield (Ibrahim, 1983 and Kataria et al., 1984). It also showed strong positive correlation with the number of mature pods (Badwal and Singh, 1973). Mohammed et al. (1973) reported positive correlation of this character with small kernel size. It exhibited significant positive association with number of primary and secondary branches, significant negative association with height of plant and positive association with days to first flowering.

2.9 Sound mature kernel percentage

The sound mature kernel percentage showed significant positive association with pod yield (Deshmukh et al.,1986).

2.10 Haulms yield

The haulms yield exhibited a wide range of variation (Qadri and Khunti, 1982). It exhibited high positive correlation with the character pod yield and had a direct effect on it (Mohan et al., 1967 and Ibrahim, 1983).

2.11 Harvest Index

Harvest Index expressed a wide range of variation (Qadri and Khunti, 1982). It exhibited negative and non-significant correlation with pod yield (Ibrahim, 1983).

2.12 Oil percentage

The oil content exhibited narrow range of variation (Qadri and Khunti, 1982). It showed positive correlation with the number of pods per plant and mean weight of kernels. However significant negative association for the parameter was observed with percentage of mature pods (Shany, 1977). Negative, but non-significant association was observed for oil percentage with days to maturity and 100 pod weight (Kushwaha and Tawar, 1973). It also showed negative correlation with pod yield (Ibrahim, 1983).

2.13 Days to maturity

Earliness was recessive to late maturity and was controlled by a single factor (Badami, 1923, Patel et al., 1936 and Hassan, 1964). Days to maturity in groundnut exhibited narrow range of variation (Majumdar et al., 1969 and Qadri and Khunti, 1982). Samooro (1975) observed that pod maturity was positively correlated with the number of pods. Wu (1983) reported negative correlation of this parameter with pod yield. However positive correlation between days to maturity and pod yield per plant was also reported (Alam et al., 1985). Days to maturity also showed significant positive correlation with plant height and days to first flowering (Yadava et al., 1984). A negative, though non-significant association for the parameter was observed with oil percentage (Kushwaha and Tawar, 1973).

2.14 Path analysis

Since pod yield in groundnut is a complex character influenced by a number of components, selection for yield should also take into consideration all these components also. Correlation studies do not give a complete picture of the association between these components. Partitioning the correlation coefficients into direct and indirect effects and assessing the relative importance of each causal factor affecting final pod yield in groundnut is important. Relevant studies in path coefficient analysis of groundnut are presented below.

The number of mature pods per plant showed significant positive direct effect on pod yield in groundnut (Badwal and Singh, 1973; Raju, 1978; Balkishan, 1979; Lakshmaiah et al., 1983 and Deshmukh et al., 1986). The 100 kernel weight also showed high positive direct effect on it. (Yadava et al., 1984 and Deshmukh et al., 1986). However, Singh et al.(1984) observed a high indirect effect for 100 kernel weight on pod yield. The character, 100 pod weight and sound mature kernel percentage also expressed high positive direct influence on pod yield. (Deshmukh et al., 1986). Pod yield was however indirectly influenced by shelling percentage (Badwal and Singh, 1973). Haulms yield in groundnut exhibited very high direct effect on pod yield (Ibrahim, 1983). He added that all other yield components including the number of mature pods influenced pod yield, only through the yield of haulms. The days to first flowering had direct negative influence on pod yield; however the number of days to maturity showed a high positive direct effect on it (Yadava et al.,1984). Height of plant showed negative direct effect on pod yield (Yadava et al., 1981 and Lakshmaiah et al., 1983). Number of primary and secondary branches exhibited positive direct effect on this character (Lakshmaiah et al., 1983 and Yadava et al., 1984). Badwal and Singh (1973) however, observed indirect effect for the number of secondaries on pod yield.

2.15 Genotype X environment interaction

Like other dryland crops, groundnut is grown over a wide range of environment. Dixit et al.(1970)observed that environment had great influence on the various quantitative characters in groundnut and that the observed variability comprised of both heritable and non-heritable components. Studies on genotype x environment interaction in groundnut are limited. The available literature on this aspect are presented below.

The most important economic character viz, pod yield showed high genotype x environment interaction. The 100 kernel weight in groundnut also was highly influenced by the environment (Yadava and Kumar, 1978, Kumar et al., 1984 and Norden et al., 1986). High environmental influence was exhibited by oil percentage and number of days to maturity (Yadava and Kumar, 1979). Norden et al.(1986) also observed high genotype x environment interaction for shelling percentage and sound mature kernel yield.

2.16 Breeding for earliness

In India nearly 81 per cent of the total groundnut produced is used for oil extraction, 12 per cent for seed purpose, 6 per cent for direct consumption and one per cent for export trade in the form of HPS (hand picked selections) kernels. As such, high yield coupled with high shelling percentage and oil content are the primary requisites of a groundnut variety for Indian conditions. In addition, the variety should fit into periods of availability of soil moisture decided by rainfall patterns and also into the practices of inter-cropping and crop ratations practised in different regions. Drought tolerance, fresh seed dormancy and resistance to pests and diseases are additional requirements of an ideal variety.

Summer varieties should, in addition to high yield and superior quality, possess early maturity, responsiveness to fertiliser application and fresh seed dormancy (Tiwari, 1983). Early maturing groundnut varieties are required for certain parts of the country to suit rainfall patterns, crop rotation systems, availability of water in the irrigation sources and also to exploit the short fallow time encountered in the cropping pattern. In Kerala, early maturing groundnut varieties are required to exploit the short gap of less than 100 days available after the two rice crop seasons. This can be materialised by identifying early maturing genotypes or incorporating earliness into the present popular varieties. Earliness combined with good kernel yield would ensure stable production in poor rainfall areas (Donald, 1984).

To incorporate earliness into the present popular varieties, breeding programmes have been launched at the International Crop Research Institute for Semi-Arid Tropics, Hyderabad and at various AICORPO groundnut centres. The sources of earliness used here are Chico, Robut 33-1, 91176, TGE 1 and TGE 2. Chico is a very early, small poded and small kernelled Spanish genotype from Russia. TGE 1 was reported to be as early as 'Chico', but superior in pod yield, shelling percentage and oil content and possess foliaceous stipules as a genetic marker (Mouli and Kale, 1982).

For identifying early maturing genotypes, it is quite essential to determine their time of optimum maturity. Groundnut is unique compared to other crops in that it has indeterminate growth habit and produce pods within the soil. So pod maturation in groundnut is a cumulative and subterranean process, which makes determination of time of optimum maturity difficult. Maturity determination is further complicated by soil and atmospheric factors (Rao and Gibbons, 1984).

In order to determine the level of maturity of pods and to precisely determine the time of optimum maturity, it invariably requires a systematic and periodical unearthing of pods for quantitative and qualitative analysis. For enabling this, the staggered system of harvesting may be adopted wherein lines under evaluation are harvested at pre-defined intervals from randomised and replicated field plots (Rao and Gibbons,1984).

Thereafter the components associated with crop maturity are analysed and time of optimum maturity determined as that point of time when the various maturity related characters attained their peak values.

Decisions made jointly on a number of dependent characters were more representative than those drawn from a direct observation on the final pod yield alone (Arunachalam and Bandyopadhyay, 1984). Maturity in groundnut is a function of several components which are related to its physiological maturation. The important characters determining the level of physiological maturity in groundnut are pod yield, sound mature kernel yield, 100 pod weight, 100 kernel weight, shelling percentage and sound mature kernel percentage (Rao and Gibbons, 1984). Adopting the staggered harvesting approach they discovered that early maturing varieties unless harvested early did not exhibit any significant advantage in yield. They also observed that a variety that gave maximum yield at 90 DAS may also show superiority when harvested at 75 DAS.

Improved methods for assessing pod maturity in groundnut are available, which include the determination of Oil Index (Gupton and Emery, 1970) and the determination of Arginine Maturity Index (Tai and Young, 1977). Gupton and Emery (1970) estimated heritability of maturity as measured by the percentage of light transmitted through oil expressed from kernel. This gave the Oil Index. Tai and Young (1977) obtained high values of broad sense heritability for the level of arginine in groundnut cultivars. The higher broad-sense heritability for free arginine level emphasised the use of Arginine Maturity Index as a measure of maturity.

Anon (1985) studied the flowering pattern of groundnut in relation to crop duration and observed that early maturing genotypes like Chico, ICGS(E) 52 and Gangapuri flowered at a rapid rate upto 44 to 47 DAS and further produced flowers at a slower rate upto 65 to 70 DAS after which they ceased to flower.

The use of early maturing groundnut varieties favours the probability of rains on the crop at or immediately after maturity. So it becomes necessary for early maturing varieties to have fresh seed dormancy.

Several early maturing dormant lines have been identified from within populations derived from crossing early, non-dormant types with late dormant types (Donald, 1984).

Sources of earliness can be treated with physical and chemical mutagens to generate new variability within the existing genetic base. Studies have shown that earliness can be combined with high yield and superior pod and kernel characters (Anon, 1981 and Donald, 1984). Earliness combined with good kernel yield would provide stable production in poor rainfall areas.

MATERIALS AND METHODS

MATERIALS AND METHODS

The present investigation was undertaken with the objectives of analysing the various characters related to maturity, determining the time of optimum maturity and identifying the early maturing genotypes in bunch groundnut. The materials used and the methods adopted for the study are given below.

3.1 MATERIALS

3.1.1 Experimental site, soil and season

The present study was conducted at the Instructional Farm of the College of Agriculture, Vellayani, located at 8.5°N latitude and 76.9°E longitude and at an altitude of 29 metres above MSL, in red loam soil. The field experiment was conducted during kharif 1988 (June 27 to October 15).

3.1.2 Weather conditions

The experimental site enjoys a humid tropical climate. Data on the maximum and minimum temperatures, rainfall and relative humidity during the entire cropping period are presented as weekly averages in Appendix I.

3.1.3 Genotypes used

The study was undertaken using fifteen bunch genotypes of groundnut (Arachis hypogaea L.) belonging to the Spanish-Valencia group. These included fourteen genotypes maintained under the Department of Plant Breeding, College of Agriculture, Vellayani, and Chico procured from International Crop Research Institute for Semi-Arid Tropics, Pattancheru, Hyderabad. JL 24 and TG 14 were used as yield checks and Chico as the duration check.

3.2 METHODS

3.2.1 Design and layout

The experiment was laid out in a split plot design. The time of harvest was alloted to main plots and the experimental genotypes to subplots with four replications, in order to facilitate staggered harvest. Each subplot was represented by a single row of four metres length with a spacing of 30 x 20 cm. Border of one metre width was maintained between two replications. The main plot treatments were alloted at random and within each main plot, the genotypes were randomly alloted to subplots.

3.2.2 Treatments

Fifteen genotypes (see table 1) were evaluated at five days of harvest viz., 70, 80, 90, 100 and 110 days after sowing (DAS).

Table 1. List of genotypes used for the study

Sl. No.	Code No.	Name of genotype	Evolved at/ Procured from
1	g_1	IES 881	AICORPO Trial.
2	g_2	IES 882	"
3	g_3	IES 883	"
4	g_4	IES 885	"
5	g_5	ICGS(E) 21	ICRISAT,Hyderabad
6	g_6	ICGS(E) 52	"
7	g_7	ICGS(E) 121	"
8	g_8	Dh(E) 20	Dharwad
9	g_9	Dh(E) 32	"
10	g_{10}	BPG 521	Bapatla
11	g_{11}	JL 24 (yield check)	Julgaon, Gujarat.
12	g_{12}	TMV 2	Tindivanam.
13	g_{13}	TG 3	BARC, Trombay.
14	g_{14}	TG 14 (yield check)	"
15	g_{15}	Chico (duration check)	ICRISAT, Hyderabad.

3.2.3 Treatment combinations

Treatment combinations in the present study are as follows.

$T_{1}-h_{1}g_{1}$	$T_{16}-h_{2}g_{1}$	$T_{31}-h_{3}g_{1}$	$T_{46}-h_{4}g_{1}$	$T_{61}-h_{5}g_{1}$
$T_{2}-h_{1}g_{2}$	$T_{17}-h_{2}g_{2}$	$T_{32}-h_{3}g_{2}$	$T_{47}-h_{4}g_{2}$	$T_{62}-h_{5}g_{2}$
$T_{3}-h_{1}g_{3}$	$T_{18}-h_{2}g_{3}$	$T_{33}-h_{3}g_{3}$	$T_{48}-h_{4}g_{3}$	$T_{63}-h_{5}g_{3}$
$T_{4}-h_{1}g_{4}$	$T_{19}-h_{2}g_{4}$	$T_{34}-h_{3}g_{4}$	$T_{49}-h_{4}g_{4}$	$T_{64}-h_{5}g_{4}$
$T_{5}-h_{1}g_{5}$	$T_{20}-h_{2}g_{5}$	$T_{35}-h_{3}g_{5}$	$T_{50}-h_{4}g_{5}$	$T_{65}-h_{5}g_{5}$
$T_{6}-h_{1}g_{6}$	$T_{21}-h_{2}g_{6}$	$T_{36}-h_{3}g_{6}$	$T_{51}-h_{4}g_{6}$	$T_{66}-h_{5}g_{6}$
$T_{7}-h_{1}g_{7}$	$T_{22}-h_{2}g_{7}$	$T_{37}-h_{3}g_{7}$	$T_{52}-h_{4}g_{7}$	$T_{67}-h_{5}g_{7}$
$T_{8}-h_{1}g_{8}$	$T_{23}-h_{2}g_{8}$	$T_{38}-h_{3}g_{8}$	$T_{53}-h_{4}g_{8}$	$T_{68}-h_{5}g_{8}$
$T_{9}-h_{1}g_{9}$	$T_{24}-h_{2}g_{9}$	$T_{39}-h_{3}g_{9}$	$T_{54}-h_{4}g_{9}$	$T_{69}-h_{5}g_{9}$
$T_{10}-h_{1}g_{10}$	$T_{25}-h_{2}g_{10}$	$T_{40}-h_{3}g_{10}$	$T_{55}-h_{4}g_{10}$	$T_{70}-h_{5}g_{10}$
$T_{11}-h_{1}g_{11}$	$T_{26}-h_{2}g_{11}$	$T_{41}-h_{3}g_{11}$	$T_{56}-h_{4}g_{11}$	$T_{71}-h_{5}g_{11}$
$T_{12}-h_{1}g_{12}$	$T_{27}-h_{2}g_{12}$	$T_{42}-h_{3}g_{12}$	$T_{57}-h_{4}g_{12}$	$T_{72}-h_{5}g_{12}$
$T_{13}-h_{1}g_{13}$	$T_{28}-h_{2}g_{13}$	$T_{43}-h_{3}g_{13}$	$T_{58}-h_{4}g_{13}$	$T_{73}-h_{5}g_{13}$
$T_{14}-h_{1}g_{14}$	$T_{29}-h_{2}g_{14}$	$T_{44}-h_{3}g_{14}$	$T_{59}-h_{4}g_{14}$	$T_{74}-h_{5}g_{14}$
$T_{15}-h_{1}g_{15}$	$T_{30}-h_{2}g_{15}$	$T_{45}-h_{3}g_{15}$	$T_{60}-h_{4}g_{15}$	$T_{75}-h_{5}g_{15}$

where T_1 to T_{75} represent treatment combinations from 1 to 75.

h_1, h_2, h_3, h_4 and h_5 correspond to harvests at 70, 80, 90, 100 and 110 DAS respectively.

g_1 to g_{15} represent the genotypes.

3.2.4 Agronomic practices

All agronomic practices in the field were done as per the package of practices recommendations of the Kerala Agricultural University (Anon, 1989).

3.2.5 Harvesting

The staggered system of harvesting (Rao and Gibbons, 1984) was adopted, wherein the genotypes were harvested at 70, 80, 90, 100 and 110 days after sowing (DAS).

3.2.6 Observations taken

A set of biometric observations on various parameters were taken from the genotypes at each harvest. Observations were recorded from ten randomly selected sample plants for each replication, and the mean values were computed to represent each parameter.

1. Height of plant

The length of the main axis from the base to the apical bud was measured to obtain the height of plant

2. Days to flower

The number of days after sowing the first flower appeared on the plant was recorded.

3. Number of branches

(i) Number of primary branches

The main stem and the branches arising directly from it were counted to obtain the number of primary branches.

(ii) Number of secondary branches

The lateral branches arising from all the primary branches were counted and recorded.

4. Number of mature pods

The well developed mature pods produced by the plant were counted and recorded.

5. Percentage of mature pods

The mature pods produced by the sample plants were counted and recorded. This was expressed as percentage over the total number of pods (both mature and immature) to obtain the percentage of mature pods.

6. Pod yield

Both mature and immature pods produced by the sample plants were cleaned, sun dried and weighed. The mean weight then computed to get the pod yield per plant.

7. 100 pod weight

Two random samples, each of hundred pods, were drawn and their weights were separately recorded. The mean value was then computed to obtain the 100 pod weight.

8. 100 kernel weight

Four random samples, each containing 100 kernels were drawn and their weights were separately recorded. The mean value gave the 100 kernel weight.

9. Shelling percentage

Four random samples of dry pods were drawn, separately weighed and the values recorded. The pod samples were shelled and the kernels weighed. The ratio of the weight of kernels obtained to the weight of pods shelled was taken for each sample. The mean value was computed and expressed as percentage.

10. Percentage of sound mature kernels (SMK percentage)

Four samples, each of hundred kernels, were drawn randomly and the number of bold and well-filled kernels present in each was recorded. The mean value was then computed to get the percentage of sound mature kernels.

11. Haulms yield

Fresh haulms obtained after removing the pods from all the sample plants was weighed. The mean value was computed to obtain the haulms yield per plant.

12. Harvest Index

This is the ratio of the economic yield to the biological yield. It was computed using the following equation.

$$\text{Harvest Index} = \frac{\text{Dry pod yield}}{\text{Total dry matter}}$$

13. Oil percentage

The oil percentage was estimated for each genotype by the Cold Percolation Method (Kartha and Sethi, 1957). Two samples were analysed from each replication and values recorded. The mean value gave the oil percentage.

3.2.7 Statistical analysis

The mean values computed for all the parameters from all replication were subjected to statistical analysis using the Analysis of Variance technique explained below. The mean data on the percentage of mature pods, shelling percentage and sound mature kernel percentage were subjected to Arc-Sine transformation during statistical analysis. The significance was tested adopting the F test (Cochran and Cox, 1965).

ANOVA

Source	df	M.S	F
Replication	r-1	MSR	MSR/MSE_1
Days of harvest	h-1	MSH	MSH/MSE_1
Error 1	(h-1)(r-1)	MSE_1	
Genotype	(g-1)	MSG	MSG/MSE_2
G x H interaction	(g-1)(h-1)	MSGH	$MSGH/MSE_2$
Error 2	h(g-1)(r-1)	MSE_2	
Total	hgr-1	MST	

where, r - number of replications, h - number of days of harvest and g- number of genotypes.

Ranking of genotypes was done using the critical difference (CD).

$$CD = t_{e\ 0.05} \sqrt{\frac{2\ MSE}{r}}$$

RESULTS

An investigation was undertaken with the objectives of analysing the various maturity related characters, determining the time of optimum maturity and identifying the early maturing genotypes, in bunch groundnut. The results of the experiment are presented below as the direct effects of time of harvest and genotypes and as their interaction effects on the various parameters.

4.1 Direct effects of time of harvest and genotypes

4.1. 1 Height of plant

The mean data on the height of plant are presented in table 2.

Days of harvest significantly influenced the height of plant. The maximum height (57.69 cm) was noticed at 100 DAS. However this was statistically on par with the plant height obtained at 90 and 110 DAS.

The genotypes also influenced this parameter significantly. Maximum height was exhibited by TMV 2(61.45 cm) but it was statistically on par with that of the yield check TG 14 and IES 881. Chico, the duration check, turned out to be the shortest (41.54 cm).

Table 2. Influence of time of harvest and genotypes on the various parameters.

	Height of plant (cm)	Days to first flowering.	Number of primary branches (per plant)	Number of secondary branches (per plant)	Number of mature pods (per plant)	Per* cent age of mature pods	Pod yield (g/plant)
Harvests (h)							
70 DAS	49.08		5.68	3.77	7.20	55.15	4.33
80 DAS	53.63		6.73	4.72	10.30	54.25	7.37
90 DAS	57.63		6.83	4.91	13.21	59.47	11.06
100 DAS	57.69		6.83	4.96	13.77	61.49	11.63
110 DAS	57.66		6.82	4.96	13.77	63.03	10.43
F(4,12)	422.94**		34.00**	567.26**	239.08**	937.14**	1517.77**
SE(h) ±	0.185		0.086	0.021	0.195	0.107	0.088
CD(0.05)	0.571		0.265	0.066	0.600	0.330	0.271
cv(h)	0.349		1.309	0.458	1.647	0.196	0.956
Genotypes (g)							
IES 881	60.95	19.75	5.02	5.28	10.78	60.11	9.30
IES 882	49.78	22.00	5.89	5.73	12.63	56.36	9.57
IES 883	59.67	21.75	6.65	4.71	12.19	59.44	9.27
IES 885	51.04	20.87	6.61	3.50	11.19	61.73	8.10
ICGS(E) 21	52.04	21.01	6.60	4.64	11.92	57.35	9.01
ICGS(E)52	46.93	21 67	7.23	4.60	11.41	57.48	9.69
ICGS(E)121	54.32	20.00	6.26	4.37	12.39	58.51	9.64
Dh(E) 20	58.22	21.50	6.51	2.17	11.18	58.12	8.13
Dh(E) 32	58.31	21.61	6.39	2.61	11.49	59.77	8.07
BPG 521	56 39	21.75	6.87	3.75	8.66	56.72	7.56
JL 24	59.57	21.90	6.42	4.80	9.06	59.12	9.49
TMV 2	61.45	21.70	6.63	5.72	10.52	58.84	8.81
TG 3	55.44	21.67	7.68	6.72	10.65	55.95	9.45
TG 14	61.43	21.85	7.84	5.74	11.11	60.99	10.06
Chico	41.54	19.20	6.07	5.62	18.15	59.69	8.29
F(14,210)	543.10**	53 33**	40.07**	587.92**	333.92**	566.39**	80.28**
SE(g) ±	0.302	0 113	0.109	0.051	0.175	0.139	0.112
CD(0.05)	0.836	0 313	0.271	0.128	0.486	0.385	0.312
cv(g)	0.567	0 534	1.658	1.100	1.477	0.255	1.219

* Arc-sine transformed values. DAS – days after sowing

** Significant at 1% level.

The interaction effects between the days of harvest and the genotypes were also found to be very significant.

4.1.2 Days to flower

The mean data on the days to first flowering are presented in table 2.

The genotypes showed significant influence on this character. Chico, the duration check, was the earliest to flower (19.20 DAS) among all the genotypes tried; IES 882 was the last to flower (22.00 DAS).

4.1.3 Number of branches

(i) Number of primary branches

The mean data on the number of primary branches per plant are given in table 2.

A perusal of the data shows that this parameter was significantly influenced by the time of harvest. It showed a significant increase between 70 and 80 DAS. Further no significant change was recorded by this parameter with regard to the days of harvest. The maximum number of primary branches (6.83) was recorded at 90 DAS.

The genotypes also had significant influence on the number of primary branches per plant. The variety

TG 14(yield check) produced the largest number of primaries (7.84), but was statistically on par with TG 3 (7.68). The genotype ICGS(E) 52 exhibited the second best performance with regard to this parameter. The genotype IES 881 turned out to be the most shy branching.

The interaction effects between days of harvest and the genotypes for this character were not significant.

(ii) Number of secondary branches

The mean data on the number of secondary branches are presented in table 2.

A perusal of the data indicates that this character was significantly influenced by the days of harvest. Delaying the time of harvest significantly increased the number of secondaries upto 90 DAS, after which there occurred no significant change to this parameter. Highest value for this character (4.96) was recorded at 100 DAS.

The genotypes showed significant influence on this parameter. The variety TG 3 produced the maximum number of secondary branches (6.72). This was followed by

TG 14 (yield check), IES 882, TMV 2 and Chico (duration check), all of which were found to be on par with one another with regard to this parameter. The genotype Dh(E) 20 recorded the smallest number of secondary branches.

Genotype x days of harvest interaction was statistically not significant for this parameter too.

4.1.4 Number of mature pods

The mean data on the number of mature pods per plant are presented in table 2.

An analysis of the data shows that days of harvest significantly influenced this parameter. It showed a remarkable increase in value between 70 and 90 DAS. Afterwards it remained more or less steady, registering only a non-significant increase between the third and final harvest. Highest value for the number of mature pods (13.77) was attained at 100 DAS.

The genotypes also exerted significant influence on this paramter, with Chico, the duration check, recording the maximum value (18.15). The genotypes IES 882, ICGS(E) 121 and IES 883, whose values were on par with one another, stood second in performance with regard to the number of mature pods. BPG 521 gave the lowest value (8.66) for the parameter.

The number of mature pods per plant was also significantly influenced by the genotype x days of harvest interaction.

4.1.5 Percentage of mature pods

The mean data (transformed) on the percentage of mature pod are presented in table 2.

Days of harvest significantly influenced this parameter and it recorded the highest value (63.03) at 110 DAS. A significant increase in value was observed with each successive harvest interval from the first to the final harvest.

Percentage of mature pods was also greatly influenced by the genotypes. Among the genotypes, IES 885 turned out to be the most superior (61.73) followed by the yield check TG 14. TG 3 recorded the lowest value (55.95) for this character.

The genotype x days of harvest interaction for this character also was significant.

4.1.6 Pod yield

The mean data on dry pod yield per plant are presented in table 2.

A perusal of the data indicates that days of harvest had significant effect on this parameter. The pod yield showed a steep increase from 70 to 90 DAS. Between 90 and 100 DAS the increase was only marginal. The maximum pod yield was recorded at 100 DAS (11.63 g). A delay in the time of harvest after 100 DAS effected a significant decline in pod yield.

The genotypes also showed significant influence on this parameter. The yield check TG 14 recorded the maximum value (10.06 g), followed by ICGS(E) 52 (9.69 g). The performance of ICGS(E)121, TMV 2, the yield check JL 24 and TG 3 were however on par with that of ICGS(E)52. The genotype BPG 521 recorded the lowest value (7.56 g).

Genotype X days of harvest interaction also showed high significance with regard to pod yield.

4.1.7 100 pod weight

The mean data on 100 pod weight are presented in table 3.

Table 3. Influence of time of harvest and genotypes on the various parameters

	100 pod weight (g)	100 kernal weight (g)	Shelling* percentage (%)	SMK * percentage (%)	Haulms yield (g)	Harvest Index	Oil percentage (%)
Harvests(h)							
70 DAS	70.48	29.56	54.49	59.22	62.06	0.130	34.07
80 DAS	72.63	30.43	54.62	60.68	72.01	0.154	41.35
90 DAS	83.98	35.22	58.23	66.18	73.54	0.181	43.94
100 DAS	86.41	36.35	58.36	66.08	70.84	0.202	45.62
110 DAS	79.88	33.61	59.96	63.85	68.00	0.199	46.63
F(4,12)	8874.80**	7541.72**	437.67**	946.31**	177.04**	2095.53**	32467.67**
SE(h) ±	0.135	0.091	0.127	0.118	0.366	0.001	0.028
CD(0.05)	0.416	0.281	0.391	0.363	1.127	0.002	0.110
cv(h)	0.179	0.239	0.224	0.189	0.515	0.390	0.066
Genotypes (g)							
IES 881	85.27	35.80	58.39	65.60	76.86	0.17	45.57
IES 882	72.13	30.30	57.72	62.24	70.75	0.17	43.62
IES 883	73.87	30.20	57.21	63.62	63.45	0.19	41.83
IES 885	76.93	31.54	50.86	64.79	61.29	0.18	41.87
ICGS(E)21	75.47	30.19	56.47	61.88	67.91	0.18	40.90
ICGS(E)52	76.30	32.81	59.50	63.57	74.51	0.17	41.89
ICGS(E)121	83.04	35.70	59.07	58.32	65.47	0.19	42.73
Dh(E)20	73.92	29.57	57.19	62.59	62.54	0.18	40.92
Dh(E)32	72.21	29.57	58.65	62.69	62.70	0.18	40.33
BPG 521	85.82	36.03	57.83	62.99	67.60	0.16	42.29
JL 24	90.45	38.56	60.17	63.61	74.10	0.15	41.53
TMV 2	81.92	35.14	56.96	64.38	78.84	0.16	43.16
TG 3	87.64	37.68	57.44	64.99	79.60	0.17	41.75
TG 14	96.75	41.55	59.18	61.85	80.74	0.17	42.35
Chico	48.38	20.78	52.32	64.88	52.97	0.18	44.10
F(14,210)	546.29**	150.36**	64.95**	101.78**	189.74**	161.40**	826.00**
SE(g) ±	0.449	0.232	0.245	0.198	0.548	0.001	0.047
CD(0.05)	1.244	0.644	0.679	0.547	1.526	0.002	0.133
cv (g)	0.593	0.610	0.433	0.316	0.771	0.484	0.112

* Arc-Sine transformed values

** Significant at 1% level.

DAS- days after sowing

Delay in the time of harvest from 70 to 110 DAS effected significant changes in the 100 pod weight. It recorded a gradual increase from 70 to 80 DAS, followed by an appreciable increase upto 90 DAS. It further showed a slow increase to record a peak value (86.41 g) at 100 DAS. The final harvest however witnessed a significant reduction in the value of this parameter.

The 100 pod weight also varied significantly among the different genotypes. TG 14 (yield check) turned out to be the most superior in 100 pod weight (96.75 g). JL 24 (yield check), with a value of 90.45 g ranked second among the various genotypes. Chico (duration check) gave the lowest value (48.38 g).

The interaction effects between genotypes and the days of harvest also showed high significance with regard to this parameter.

4.1.8 100 kernel weight

The mean data on 100 kernel weight are presented in table 3.

The time of harvest significantly influenced the 100 kernel weight. The variation of this parameter with respect to the days of harvest followed a more or less similar pattern as of 100 pod weight. Peak value (36.35 g) for the parameter was recorded at the fourth harvest (100 DAS).

The genotypes varied significantly with respect to the 100 kernel weight. TG 14 (yield check) registered the highest value (41.55 g) for this parameter, followed by JL 24 (yield check) (38.56 g). Chico, the duration check, recorded the lowest value (20.78 g).

The genotype X days of harvest interaction also showed high significance for this character.

4.1.9 Shelling percentage

The mean data (transformed) on shelling percentage are given in table 3.

Days of harvest significantly influenced this parameter. It showed continuous increase in value from the first harvest (70 DAS) to the final harvest (110 DAS). Maximum value (59.96 per cent) for the parameter was recorded at 100 DAS.

The genotypes also showed pronounced influence on the shelling percentage. Among them, JL 24(yield check) exhibited the top performance (60.17 per cent).

ICGS(E) 52, which came second was statistically on par with TG 14 (yield check) and ICGS(E) 121. The genotype IES 885 registered the lowest shelling percentage.

Genotype X days of harvest interaction for this parameter also was highly significant.

4.1.10 Percentage of sound mature kernels(SMK percentage)

The mean data (transformed) on SMK percentage are presented in table 3.

Days of harvest significantly influenced this parameter. The parameter significantly increased from 70 to 90 DAS, kept steady till 100 DAS and then declined significantly. Maximum value (66.18 per cent) was recorded 90 DAS.

The genotypes also varied significantly with regard to this parameter. Highest value was recorded by IES 881 (65.60 per cent), followed by TG 3, Chico (duration check) and IES 885 which recorded on par performance.

The interaction effects between genotypes and days of harvest were also found to be highly significant.

4.1.11 Haulms yield

The mean data on the yield of haulms per plant are presented in table 3.

An appraisal of the data shows that the days of harvest significantly influenced this parameter. Haulms yield exhibited a sudden increase during the first harvest interval, recording 72.01 g at 80 DAS. It showed a further marginal increase during the second harvest interval to register a peak value at 90 DAS (73.54 g). Further delay in the time of harvest caused significant decline in the haulms yield.

The genotypes also influenced this parameter significantly. TG 14 (yield check) registered the highest value (80.74 g) for haulms yield. However, it was on par with TG 3 (79.60 g). Chico (duration check) gave the lowest haulms yield (52.97 g).

The genotype X days of harvest interaction showed high significance for the yield of haulms.

4.1.12 Harvest Index

The mean data on the harvest index are presented in table 3.

A perusal of the data indicates that days of harvest had significant influence on the harvest index. It increased progressively with delay in the days of harvest upto 100 DAS. Maximum value of 0.20 for the parameter was recorded at 100 DAS. Thereafter it declined.

The genotypes also significantly influenced this parameter. IES 883 and ICGS(E) 121 gave the maximum harvest index (0.19). JL 24(yield check) registered the lowest value for harvest index among the different genotypes.

The genotype X days of harvest interaction showed high significance with regard to this parameter also.

4.1.13 Oil percentage

The mean data on oil percentage are presented in table 3.

The days of harvest significantly influenced the oil percentage. Delaying the harvest from 70 to 110 DAS progressively increase the oil content of kernels. The maximum value for this parameter (46.63 per cent) was recorded at the final harvest.

KEY

NUMBER OF MATURE PODS

POD YIELD

PERCENTAGE OF MATURE PODS

100 POD WEIGHT

100 KERNEL WEIGHT

SOUND MATURE KERNEL PERCENTAGE

SHELLING PERCENTAGE

The genotypes also showed significant variation with regard to this parameter. IES 881 registered the highest oil percentage (45.57 per cent) followed by Chico(duration check) (44.10 per cent). Dh(E) 32 gave the lowest value (40.33 per cent) for the parameter.

The genotype X days of harvest interaction also proved significant with respect to this parameter.

4.2 Interaction effects of genotypes with time of harvest

The interactions between genotypes and time of harvest were found to be highly significant for almost all characters studied, except for the number of branches (primaries and secondaries) which showed no significant interaction. The genotype X days of harvest interactions for the various characters studied are presented below.

4.2.1 IES 881

The mean data on the interactions of this genotype are presented in table 4 and illustrated in figure 1.

(i) Height of plant

Plant height showed steady increase between 70 and 90 DAS and recorded a maximum value of 64.93 cm

Table 4. Interaction of genotypes (g_1, g_2 and g_3) with time of harvest.

Genotypes X Days of harvest	Height of plant (cm)	Number of mature pods	Percentage of mature pods.*	Pod yield (g/plant)	100 pod weight (g)	100 kernal weight (g)	Shelling percentage (%)*	SMK percentage (%)*	Haulms yield (g/plant)	Harvest Index	Oil percentage (%)
g_1 (IES 881)											
70 DAS	51.33	5.73	57.22	4.43	76.02	32.00	56.55	63.74	68. 3	0 15	37 85
80 DAS	58.85	8.83	56.88	6.20	74.48	31.28	51.19	60.20	77.10	0.16	44 40
90 DAS	64.93	12.15	61.07	11.17	88.50	37.01	61.99	65.49	82 30	0. 7	46.35
100 DAS	64.83	13.38	62.28	13.12	96.16	40.38	60.02	68.33	79.20	0.19	49.10
110 DAS	64.80	13.80	63.10	11.60	91.21	38.31	62.20	70.26	77.38	0.19	50.15
g_2 (IES 882)											
70 DAS	44.23	7.05	52.47	4.27	57.60	24.19	57.07	57.39	65.38	0.13	35.10
80 DAS	47.80	12.23	53.62	9.15	76.60	32.17	55.35	60.91	76.10	0.17	44.95
90 DAS	52.23	14.33	58.41	12.67	81.30	34.15	60.34	66.50	72.35	0 20	45 40
100 DAS	52.35	14 78	58.57	11.77	76.75	32.24	57.26	64.93	71.60	0.20	46 05
110 DAS	52.30	14.78	58 72	9.98	68.43	28.74	58.56	61.47	68.33	0.17	46.60
g_3 (IES 883)											
70 DAS	55.82	6.95	58.34	4.38	70.70	28.99	55.61	60.70	57.38	0.17	36.40
80 DAS	57.18	11.80	50.76	9.13	67.58	27.71	54.17	57.98	69.33	0.16	40 05
90 DAS	61.75	14.33	61.76	12.00	88.27	36.19	58.88	68.73	60.12	0.21	42.15
100 DAS	61.83	14.10	62.88	11.15	75.65	31.02	58.12	67.10	64 2?	0.20	45.10
110 DAS	61.78	13.75	63.44	9.70	67.15	27.53	59.26	63.58	60.18	0.21	45.45
F(56,210)	5.49**	7.05**	150.21**	43.06**	97.15**	44.31**	25.73**	71.53**	11 53**	96.87**	144 17**
SE(gh) ±	0.670	0.390	0.311	0.251	1.003	0.519	0.548	0.442	1.225	0.002	0.106
CD(0.05)	1 220	0 8.7	0.596	0.485	1.658	0 876	0.959	0.794	2.268	0.004	0.202
cv(gh)	1 2 5	3.	0 .09	2.727	1.326	1.364	0.968	0.707	1.725	1.082	0 250

* Arc-sine transformed values

** Significant at [illegible] level

g- genotypes

h - days of harvest

KEY

•----• NUMBER OF MATURE PODS

o——• POD YIELD

o----o PERCENTAGE OF MATURE PODS

•——o 100 POD WEIGHT

o----o 100 KERNEL WEIGHT

o——o SOUND MATURE KERNEL PERCENTAGE

o——o SHELLING PERCENTAGE

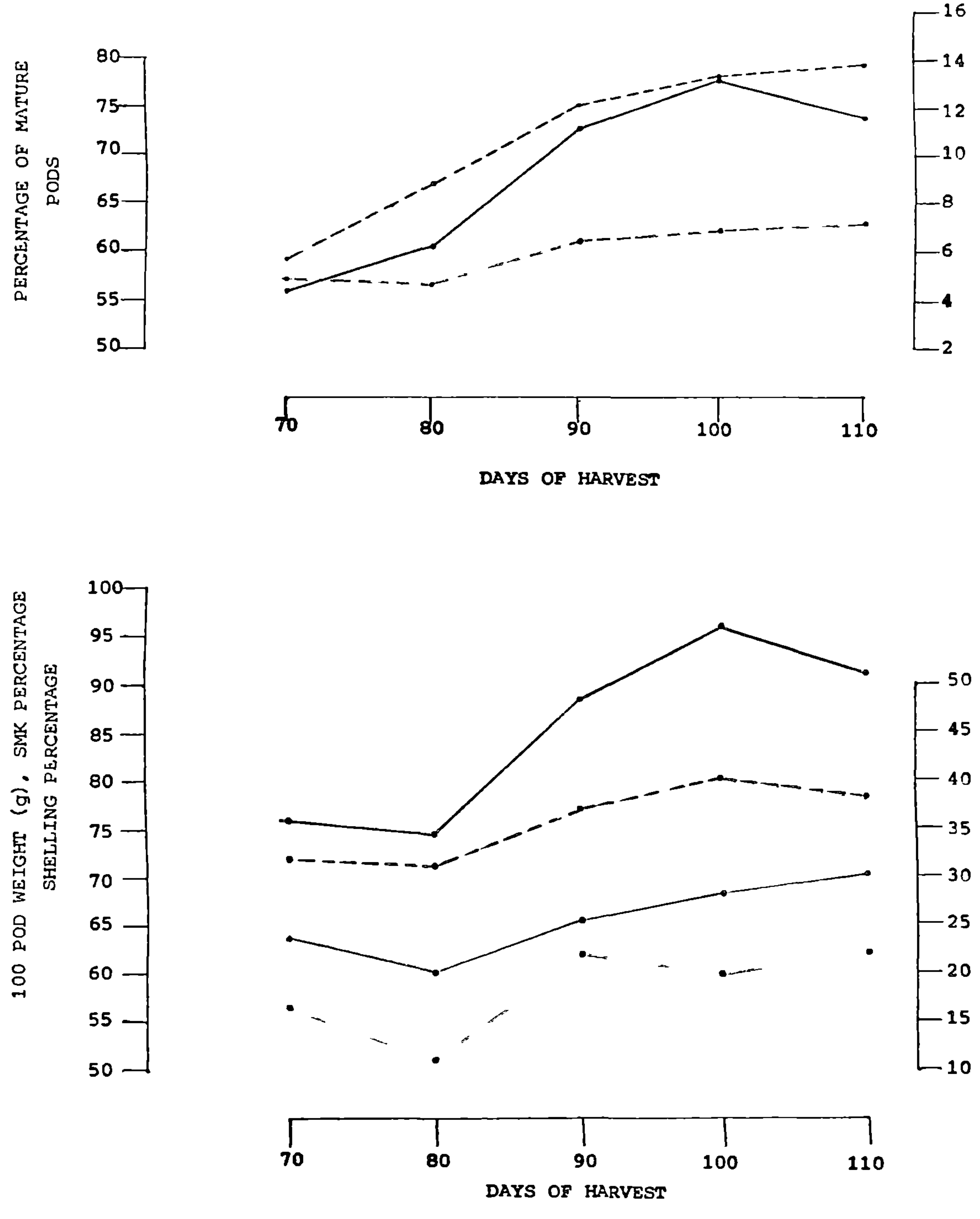

Fig. 1. Effect of staggered harvests on yield and component characters of the genotype IES 881.

in the third harvest. After 90 DAS, it did not register any further significant change.

(ii) Number of mature pods

The genotype exhibited highly significant interaction with the days of harvest for this parameter. The parameter showed continuous increase in value from 70 to 110 DAS. The maximum value was recorded at the final harvest (13.80). However, an on par value was also obtained at 100 DAS(13.38).

(iii) Percentage of mature pods

The genotype exhibited a non-significant decline in the percentage of mature pods, when the harvest was delayed from 70 to 80 DAS. Thereafter an appreciable increase for the character was manifested till 90 DAS. Between 90 and 110 DAS, there was a further gradual increase, resulting in a maximum value for the parameter (63.10) at the final harvest.

(iv) Pod yield

The character registered a slow increase in value between 70 and 80 DAS. However a steep increase in pod yield for this genotype was registered between 80 and 100 DAS. Peak pod yield (13.12 g) was obtained at the third harvest. Thereafter the parameter showed a declining trend.

(v) 100 pod weight

Between 70 and 80 DAS, the value of this parameter showed a non-significant declining trend. Further it showed an appreciable increase till 100 DAS, when the peak value of 96.16 g was recorded. Thereafter a decline in the parameter was observed. From 80 to 90 DAS, the 100 pod weight increased at a faster rate than between 90 and 100 DAS.

(vi) 100 kernel weight

The 100 kernel weight also varied in a more or less similar pattern as the 100 pod weight for this genotype. It also recorded the peak value at 100 DAS (40.38 g).

(vii) Shelling percentage

This character also showed a declining trend between 70 and 80 DAS. It further exhibited a steep increase between 80 and 90 DAS followed by a gradual decline in value upto 100 DAS. Beyond 100 DAS the value again showed a gradually increasing trend. The genotype recorded the maximum shelling percentage (62.20) at the final harvest. Statistical analysis however showed that the variation of this parameter after 90 DAS (when it recorded a value of 61.99), was not significant.

(viii) Sound mature kernel percentage

This parameter also recorded a declining trend between 70 and 80 DAS. Thereafter it showed continuous increase upto the final harvest, recording the highest value at 100 DAS (70.26). Between 80 and 90 DAS, the increase in magnitude for this character was at a higher rate than between 90 and 110 DAS.

(ix) Haulms yield

The haulms yield for the genotype progressively increased from 70 to 90 DAS, after which it showed progressive decline till the final harvest. Peak value for the parameter was recorded at 90 DAS(82.30 g). It was however noted that the value of the parameter at 100 and 110 DAS were statistically on par with each other.

(x) Harvest Index

Extending the time of harvest from 70 to 100 DAS progressively increased the harvest index from 0.15 to 0.19. It further kept steady till the final harvest.

(xi) Oil percentage

The genotype exhibited a continuous increase in the oil percentage from the first to the last harvest.

The maximum value for the parameter was recorded at 110 DAS(50.15). However an appreciably high oil percentage was also obtained at 100 DAS (49.10).

4.2.2 IES 882

The mean data on the interactions of this genotype are presented in table 4 and illustrated in figure 2.

(i) Height of plant

The genotype expressed a continuous increase in plant height from 70 to 90 DAS. Delaying harvest beyond 90 DAS did not cause any significant change to the height of main axis. It recorded the maximum height at 100 DAS (52.35 cm).

(ii) Number of mature pods

A remarkable increase in this parameter was obtained between 70 and 90 DAS. Further delay in time of harvest resulted only in a marginal non-significant increase for this parameter and the highest value was recorded at 100 DAS (14.78).

(iii) Percentage of mature pods

The genotype recorded a gradual increase for this parameter between 70 and 80 DAS. Thereafter it showed a

KEY

- ●– – – –● NUMBER OF MATURE PODS
- ○————● POD YIELD
- ○– – – –○ PERCENTAGE OF MATURE PODS

- ●————○ 100 POD WEIGHT
- ●– – – –○ 100 KERNEL WEIGHT
- ○————○ SOUND MATURE KERNEL PERCENTAGE
- ○————○ SHELLING PERCENTAGE

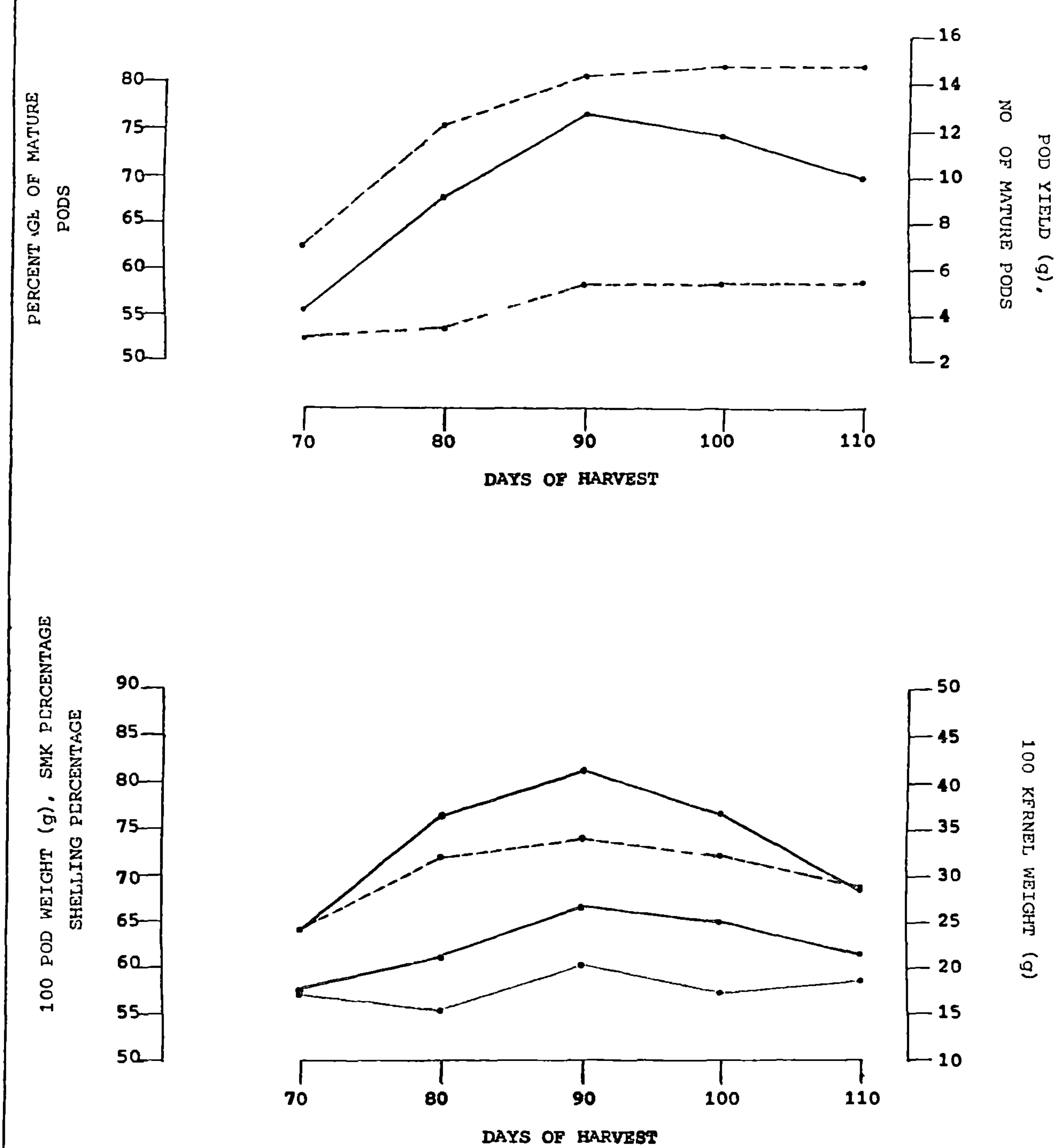

Fig.2. Effect of staggered harvests on yield and component characters of the genotype IES 882.

steep increase upto 90 DAS to attain a value of 58.41. Between 90 and 110 DAS the parameter recorded a slow and statistically non-significant increase in value, to record a maximum (58.72) at the final harvest.

(iv) Pod yield

Delaying the time of harvest from 70 to 90 DAS created a steep and more or less linear increase in this parameter. It attained a peak value at 90 DAS (12.67 g), beyond which a significant declining trend was noticed with regard to days of harvest.

(v) 100 pod weight

The genotype showed an increase for this parameter from 70 to 90 DAS, after which a decline was observed with respect to days of harvest. The character increased at a faster rate between 70 and 80 DAS, and further increased at a slower rate upto 90 DAS when it attained a peak (81.30 g). Further delay in the time of harvest significantly reduced the 100 pod weight with each successive harvest interval.

(vi) 100 kernel weight

The variation in 100 kernel weight followed a more or less similar trend as that of 100 pod weight. The peak value (34.15 g) was attained at 90 DAS.

(vii) Shelling percentage

This parameter recorded a zigzag pattern of variation, characterised by a decline in value between 70 and 80 DAS, followed by an increase upto 90 DAS, a further decline till 100 DAS and further increase during the final harvest interval. The genotype recorded maximum shelling percentage (60.34) at 90 DAS.

(viii) Sound mature kernel percentage

This parameter progressively increased with respect to the time of harvest, attained a peak at 90 DAS (66.50) and then declined in value till the final harvest. The increase was at a slightly faster rate between 80 and 90 DAS than between 70 and 80 DAS.

(ix) Haulms yield

The parameter exhibited a rapid increase during the first harvest interval, recorded a peak (76.10 g) at 80 DAS, whereafter its value declined progressively. However, haulms yield recorded at 90 and 100 DAS did not vary significantly.

(x) Harvest Index

The harvest index exhibited a significant increase in value from 70 to 90 DAS, kept steady till 100 DAS and then declined significantly at the final harvest. Maximum value was recorded at 90 DAS (0.20).

(xi) Oil percentage

A continuous increase in the oil percentage was observed with each successive harvest interval, from 70 to 110 DAS. The genotype recorded maximum value for this parameter (46.60) at 110 DAS.

4.2.3 IES 883

The mean data on the interactions of this genotype are presented in table 4 and illustrated in figure 3.

(i) Height of plant

The genotype recorded an increase in value for this parameter between 70 and 100 DAS, registering the maximum height (61.83 cm) at 100 DAS. However, statistical analysis revealed that after 90 DAS the time of harvest did not have any significant effect on this parameter.

KEY

- - - - NUMBER OF MATURE PODS

——— POD YIELD

- - - - PERCENTAGE OF MATURE PODS

——— 100 POD WEIGHT

- - - - 100 KERNEL WEIGHT

——— SOUND MATURE KERNEL PERCENTAGE

——— SHELLING PERCENTAGE

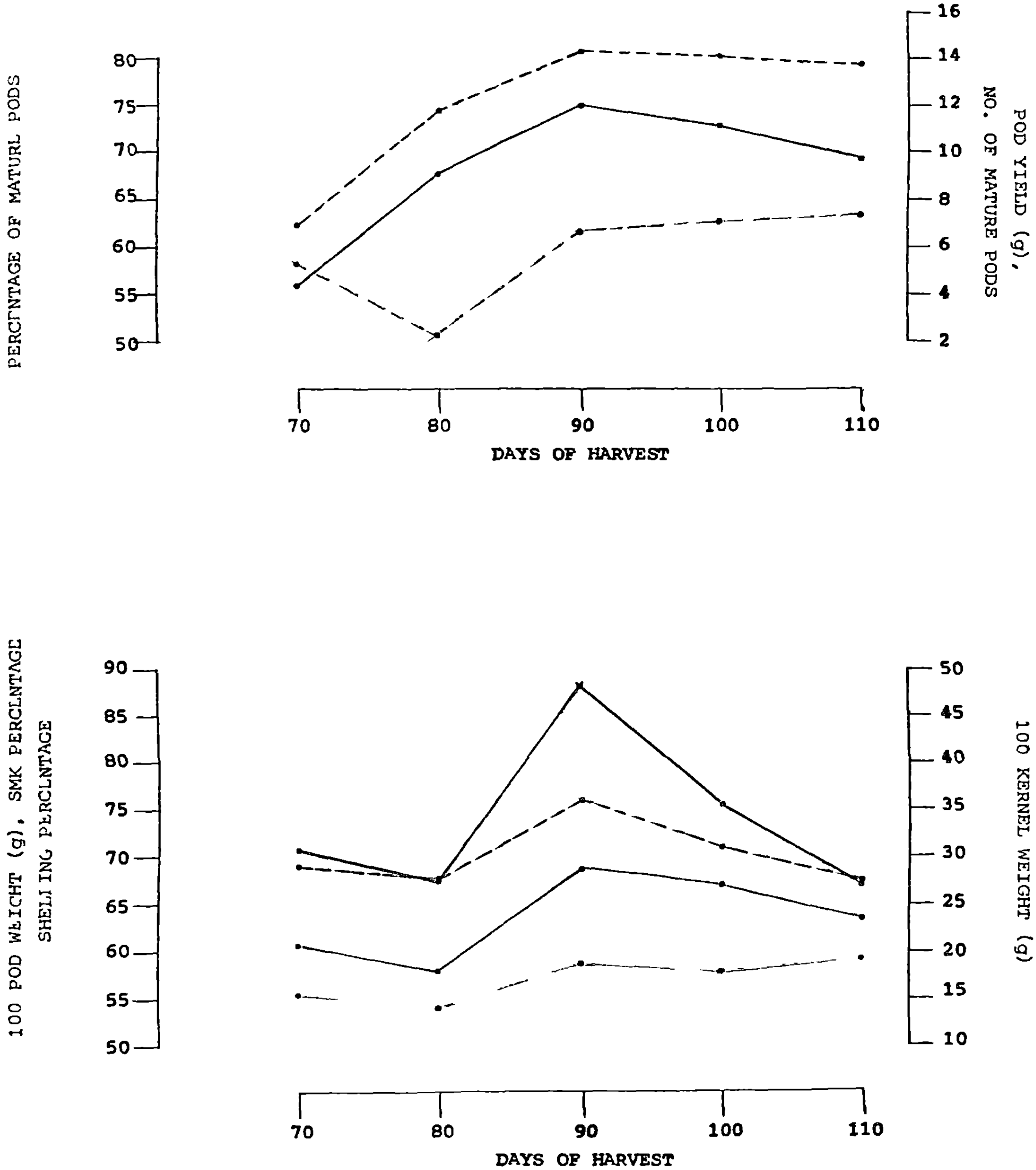

Fig.3. Effect of staggered harvests on yield and component characters of the genotype IES 883.

(ii) Number of mature pods

The genotype showed an increasing trend in this parameter between 70 and 90 DAS. Beyond 90 DAS there occured a non-significant decline. The highest value recorded at 90 DAS (14.33) was on par with that at 100 DAS (14.10) and at 110 DAS (13.75).

(iii) Percentage of mature pods

There occurred a steep decline in this parameter between 70 and 80 DAS, followed by a corresponding increase between 80 and 90 DAS. Beyond 90 DAS the parameter registered only a gradual increase in value. Maximum value for this parameter was recorded at 110 DAS (63.44), which however was on par with the value at 100 DAS (62.88).

(iv) Pod yield

Pod yield showed an increasing trend with delay in the time of harvest upto 90 DAS. Maximum value for this parameter (12.00 g) was obtained at the third harvest. Thereafter it recorded a declining trend.

(v) 100 pod weight

The genotype recorded a decline in this parameter between 70 and 80 DAS. However a spurt in 100 pod weight was observed during the subsequent harvest interval, recording a peak value(88.27 g) at 90 DAS. Thereafter there occurred drastic decline in the value of this parameter and the lowest value was recorded at the final harvest (67.15 g).

(vi) 100 kernel weight

The variation in 100 kernel weight followed a more or less similar pattern as that of 100 pod weight. The genotype expressed its peak performance for this parameter (36.19 g), also at 90 DAS.

(vii) Shelling percentage

The parameter expressed a zigzag pattern of variation with regard to the time of harvest. It recorded an initial decline in value between 70 and 80 DAS, followed by an increase from 80 to 90 DAS. It further declined during the subsequent harvest interval and again increased to record the maximum value (59.26) at

110 DAS. Statistical analysis suggested that the value recorded at 90 and 100 DAS were on par with each other.

(viii) Sound mature kernel percentage

The genotype showed an initial declining trend for this parameter during the first harvest interval, followed by a rapidly increasing trend during the second harvest interval and attained a peak value (68.73) at 90 DAS. Thereafter a declining trend was observed.

(ix) Haulms yield

The parameter exhibited a rapid increase in value during the first harvest interval, recorded a peak (69.33 g) at 80 DAS and declined with respect to further harvests. However the haulms yield recorded at 90 and 100 DAS did not vary significantly.

(x) Harvest index

This parameter exhibited a zigzag mode of variation with regard to the time of harvest. It declined between 70 and 80 DAS and also between 90 and 100 DAS. However a tremendous increase was registered for harvest index between 80 and 90 DAS. It attained maximum value both at 90 DAS and 110 DAS (0.21).

(xi) Oil percentage

Oil percentage for the genotype showed continuous increase between the first and final harvests. The genotype gave the highest oil percentage at 110 DAS (45.45). However a fairly high value (42.15) was also obtained at 90 DAS.

4.2.4 IES 885

The mean data on the interactions of this genotype is presented in table 5 and illustrated in figure 4.

(i) Height of plant

The days of harvest significantly increased the height of plant upto 90 DAS. Beyond 90 DAS, the parameter did not exhibit any significant change, eventhough the maximum value was recorded at 100 DAS (53.03 cm).

(ii) Number of mature pods

The genotype recorded a remarkable increase in the value of this parameter between 70 and 90 DAS. Thereafter it did not show any further significant increase in value, although the maximum value (13.90) was recorded at 100 DAS. Statistical analysis showed that this value was on par with that recorded at 90 DAS (13.13) and at 110 DAS (13.85).

Table 5 Interaction of genotypes (g_4, g_5 and g_6) with time of harvest

Genotypes X Days of harvest	Height of plant (cm)	Number of mature pods	Percentage of mature pods *	Pod yield (g/plant)	100 pod weight (g)	100 kernal weight (g)	Shelling percentage (°) *	SMK percentage (%) *	Haulm yield (g/plant)	Harvest Index	Oil percentage ( )
g_4 (ICS 885)											
70 DAS	46.55	5.95	59.05	3.88	75.12	30.80	47.81	60.72	55.38	0.12	35.35
80 DAS	49.70	9.10	56.79	7.03	72.95	29.91	46.20	62.02	66.23	0.17	39.95
90 DAS	52.95	13.13	62.39	10.95	84.78	34.76	54.76	69.54	63.12	0.20	43.50
100 DAS	53.03	13.90	64.05	10.15	80.98	33.20	51.76	66.68	63.48	0.21	44.90
110 DAS	52.98	13.85	66.36	8.50	70.80	29.03	53.77	65.02	58.23	0.21	45.65
g_5 (ICGS(E)21)											
70 DAS	49.10	7.13	51.23	3.93	70.01	28.00	54.76	60.01	60.18	0.12	30.95
80 DAS	50.58	10.23	54.25	8.10	76.00	30.40	55.57	62.09	74.23	0.17	40.40
90 DAS	53.32	14.05	58.04	11.95	82.95	33.18	54.02	65.50	71.52	0.20	42.60
100 DAS	53.63	14.20	61.12	11.10	78.33	31.33	56.82	61.92	69.25	0.20	44.50
110 DAS	53.58	14.01	62.09	10.00	70.05	28.02	61.16	59.90	64.38	0.20	45.05
g_6 (ICGS(E)52)											
70 DAS	43.15	6.92	51.82	4.23	65.11	28.00	57.92	55.15	70.33	0.14	30.10
80 DAS	45.85	11.98	53.77	8.05	70.05	30.12	56.76	62.73	79.33	0.16	42.00
90 DAS	48.40	15.03	58.41	12.85	88.58	38.09	61.15	68.10	76.23	0.20	44.30
100 DAS	48.65	15.05	60.15	11.95	82.73	35.57	60.33	66.52	75.33	0.19	46.10
110 DAS	48.60	15.00	63.27	11.38	75.02	32.26	61.34	65.38	71.33	0.19	46.95
$F_{(56,210)}$	5.49**	7.05**	150.21**	43.06**	97.15**	44.31**	25.73**	71.53**	11.53**	96.87**	144.17**
SE(gh)±	0.670	0.390	0.310	0.251	1.003	0.519	0.548	0.442	1.223	0.002	0.106
CD(0.05)	1.220	0.867	0.596	0.485	1.658	0.876	0.959	0.794	2.268	0.004	0.202
cv(gh)	1.268	3.304	0.569	2.727	1.326	1.364	0.968	0.707	1.725	1.082	0.250

* Arc-sine transformed values

** Significant at 1% level.

g - genotypes

h - days of harvest

KEY

NUMBER OF MATURE PODS

POD YIELD

PERCENTAGE OF MATURE PODS

100 POD WEIGHT

100 KERNEL WEIGHT

SOUND MATURE KERNEL PERCENTAGE

SHELLING PERCENTAGE

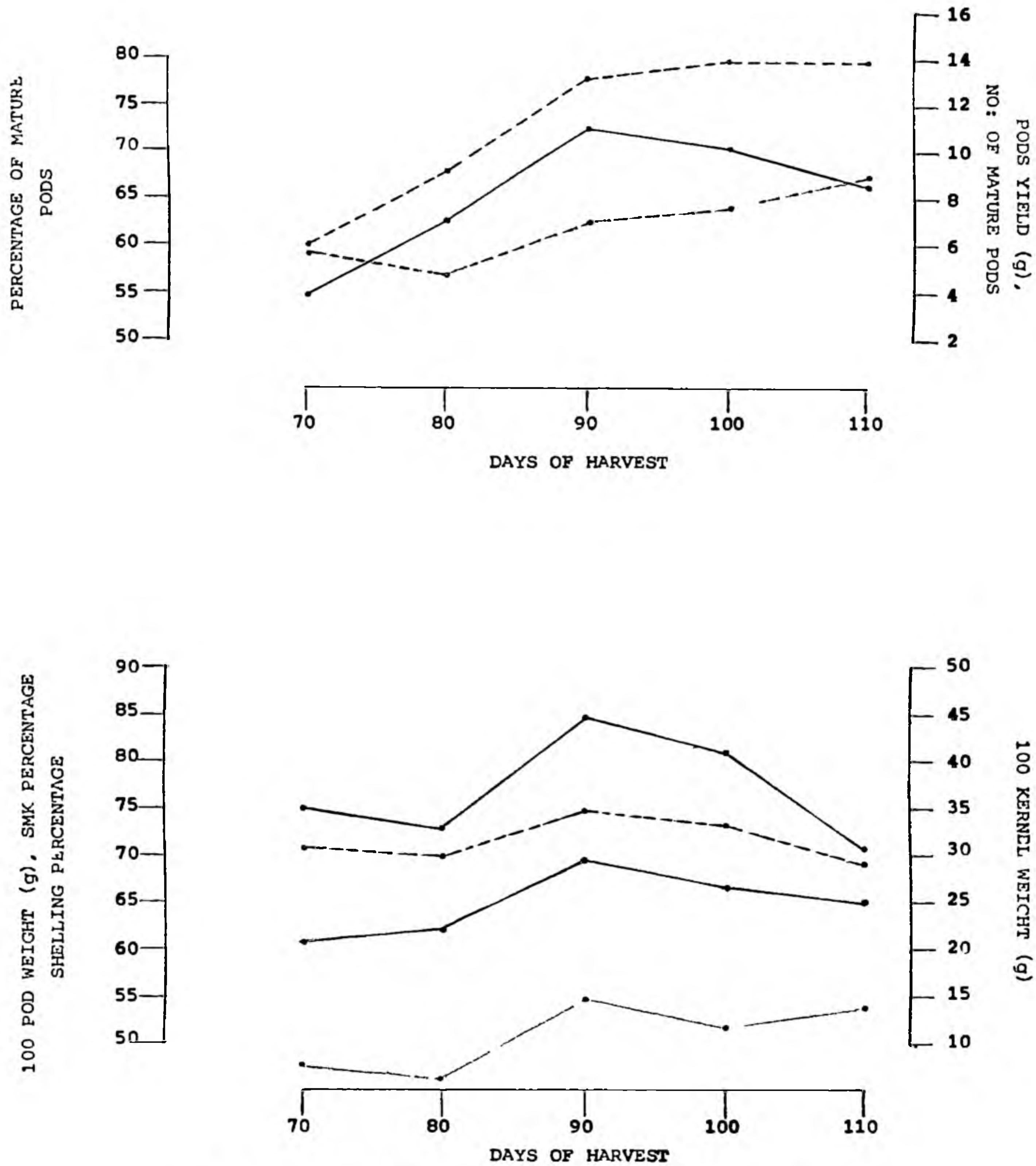

Fig. 4. Effect of staggered harvests on yield and component characters of the genotype IES 885.

(iii) Percentage of mature pods

The time interval between the first two harvest dates witnessed a decline in the value of this parameter. Thereafter an increasing trend was observed with respect to the time of harvest and the maximum value (66.36) was recorded at 110 DAS.

(iv) Pod yield

There occurred a significant hike in the pod yield between 70 and 90 DAS. It registered a peak value at 90 DAS (10.95 g) and then declined significantly with each successive harvest.

(v) 100 pod weight

The character showed an initial decline during the first harvest interval. It registered a significant increase in value between 80 and 90 DAS to attain the peak value (84.78 g) at the third harvest. Beyond 90 DAS, a decreasing trend was observed until the final harvest.

(vi) 100 kernel weight

This parameter also followed a more or less similar pattern as that of 100 pod weight. It also registered a significant increase in its value during the second harvest interval to record a peak value (34.76 g) at 90 DAS.

(vii) Shelling percentage

The parameter recorded a zigzag manner of variation with regard to the days of harvest. It showed a slight initial decline, followed by a significant increase to record a peak value (54.76) at 90 DAS. Further the value declined during third harvest interval and went on to register a gradual increase during the final harvest interval.

(viii) Sound mature kernel percentage

A gradual increase followed by an appreciable increase was noticed for this parameter upto the third harvest. It attained a peak value (69.54) at 90 DAS. However, the fourth and the final harvests effected significant decline to this parameter.

(ix) Haulms yield

The haulms yield recorded a peak value (66.23 g) at 80 DAS and declined thereafter. However the values at 90 and 100 DAS were statistically on par with each other.

(x) Harvest index

The genotype recorded a significant increase for this parameter between 70 and 100 DAS, after which it kept steady. Peak value (0.21) was obtained both at 100 and 110 DAS. Between 70 and 90 DAS there was a comparatively faster rate of increase for this parameter than between 90 and 100 DAS.

(xi) Oil percentage

The value of this parameter showed continuous increase with respect to the time of harvest from 70 to 110 DAS. It recorded the maximum value at the final harvest (45.65). However, fairly high values were also recorded for the parameter at 90 DAS (43.50) and 100 DAS (44.90).

4.2.5 ICGS(E) 21

The mean data on interactions for this genotype are presented in table 5 and illustrated in figure 5.

(i) Height of plant

The genotype recorded a significant increase in plant height between 70 and 90 DAS after which there occurred no significant change to this parameter. However the highest value for plant height was recorded at 100 DAS (53.63 cm).

KEY

NUMBER OF MATURE PODS

POD YIELD

PERCENTAGE OF MATURE PODS

100 POD WEIGHT

100 KERNEL WEIGHT

SOUND MATURE KERNEL PERCENTAGE

SHELLING PERCENTAGE

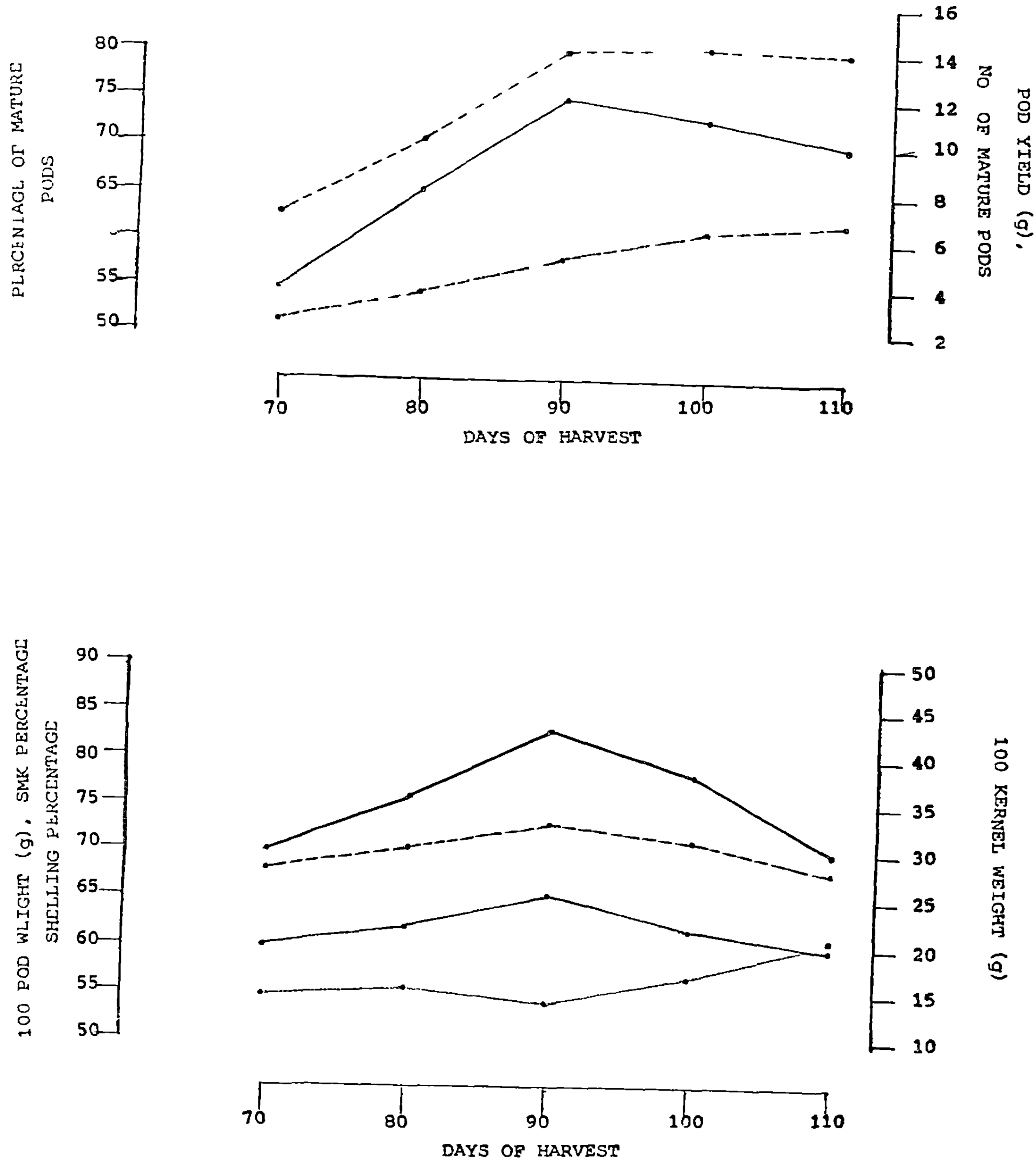

Fig. 5. Effect of staggered harvests on yield and component characters of the genotype ICGS (E) 21.

(ii) Number of mature pods

The parameter registered a steep and more or less linear increase between 70 and 90 DAS, beyond which the days of harvest did not show any significant influence on this parameters. The maximum value for this parameter (14.20) recorded at 100 DAS was statistically on par with that at 90 DAS (14.05).

(iii) Percentage of mature pods

The parameter showed progressive increase in value from the first to the final harvest. It recorded the maximum value (62.09) at 110 DAS.

(iv) Pod yield

This parameter exhibited a significant linear increase from 70 to 90 DAS. The genotype recorded the maximum pod yield at 90 DAS (11.95 g). Delaying the time of harvest beyond 90 DAS caused significant reduction in the value of this parameter.

(v) 100 pod weight

This parameter also registered a steep and more or less linear increase between 70 and 90 DAS. It attained a peak value at 90 DAS (82.95 g). Delaying the time of harvest beyond 90 DAS however caused significant reduction for this parameter.

(vi) 100 kernel weight

This character also followed a more or less similar pattern as 100 pod weight in its variation with respect to days of harvest. The genotype recorded peak value for this parameter also at 90 DAS (33.18 g).

(vii) Shelling percentage

This parameter showed a marginal and non-significant increase between 70 and 80 DAS. It registered a decline in value during the second harvest interval. Between 90 and 100 DAS the value however increased almost steadily attaining the maximum at the final harvest (61.16).

(viii) Sound mature kernel percentage

This character also followed a more or less similar pattern as that of 100 pod weight and 100 kernel weight. The genotype recorded the maximum value for this parameter also at 90 DAS (65.50).

(ix) Haulms yield

A sudden increase in the haulms yield was observed between 70 and 80 DAS. Peak value for this parameter was recorded at 80 DAS (74.23 g). Thereafter it registered a decline in value with each successive harvest interval. However, the haulms yield registered at 90 DAS (71.52 g) was statistically on par with that at 100 DAS (69.25 g).

(x) Harvest Index

The harvest index registered an abrupt increase between 70 and 80 DAS. It showed further increase during the subsequent harvest interval, registering the maximum value (0.20) at 90 DAS. The value remained steady for the remaining two harvests also.

(xi) Oil percentage

The genotype registered a continuous increase in the oil percentage between 70 and 110 DAS. It registered the maximum value for this parameter at the final harvest (45.05). However fairly high values were also obtained at 90 DAS (43.60) and 100 DAS (44.50).

4.2.6 ICGS(E) 52

The mean data on the interactions of this genotype are presented in table 5 and figure 6.

(i) Height of plant

The genotype showed an increase in this parameter from 70 to 90 DAS. Further delay in the harvest date, however, did not significantly influence the value of this parameter. The maximum plant height was obtained at 100 DAS (48.65 cm). However this was statistically on par with the value obtained at 90 DAS (48.40 cm).

KEY

NUMBER OF MATURE PODS

POD YIELD

PERCENTAGE OF MATURE PODS

100 POD WEIGHT

100 KERNEL WEIGHT

SOUND MATURE KERNEL PERCENTAGE

SHELLING PERCENTAGE

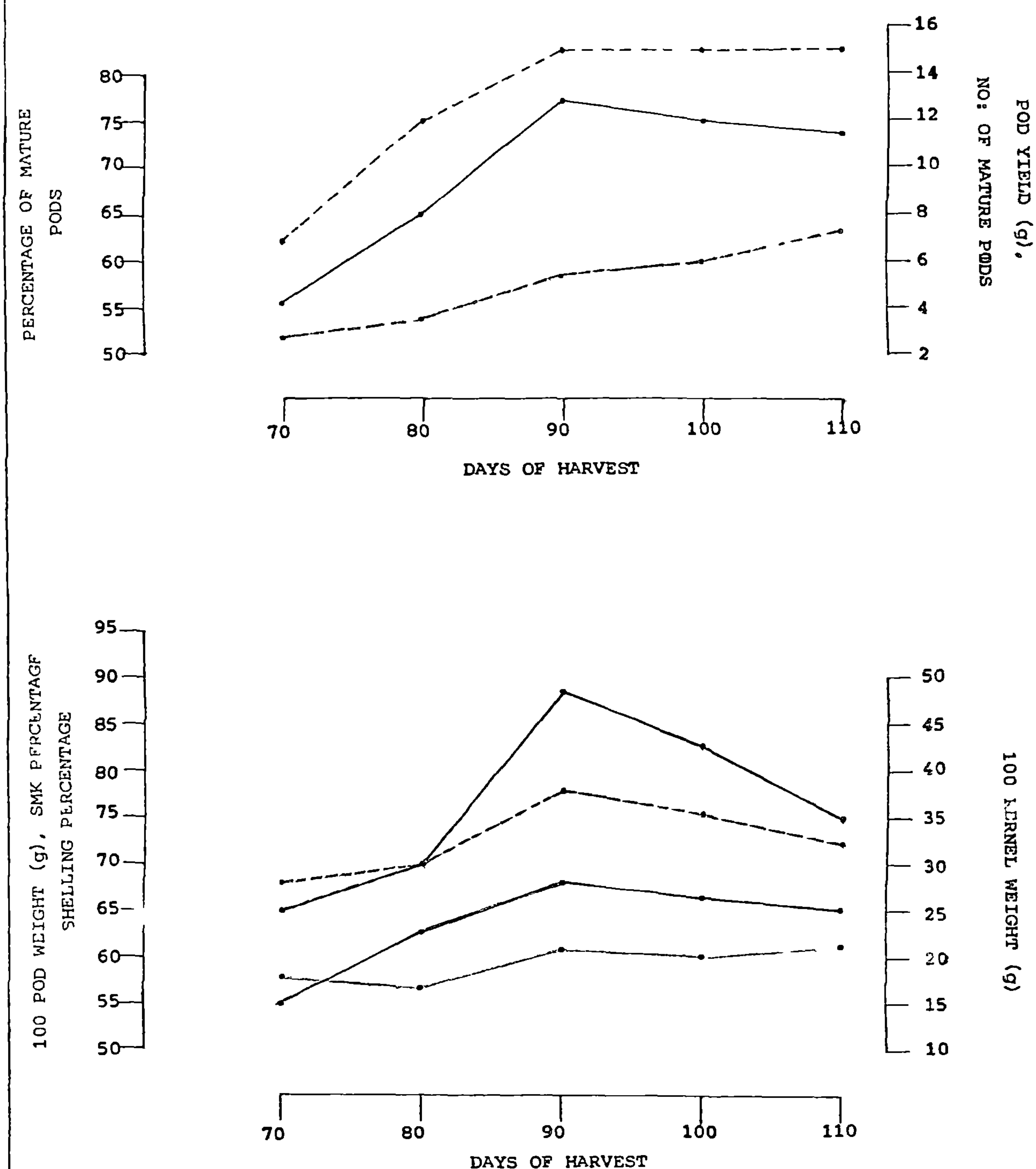

Fig.6. Effect of staggered harvests on yield and component characters of the genotype ICGS (E) 52.

(ii) Number of mature pods

The parameter recorded a steep and almost linear increase from 70 to 90 DAS, after which it remained almost steady without any further significant change. It recorded the maximum value (15.05) at 100 DAS. This was statistically on par with the value recorded at 90 DAS (15.03) and at 110 DAS (15.00).

(iii) Percentage of mature pods

This parameter followed a gradual increase with respect to the time of harvest from 70 to 110 DAS. It recorded a maximum value at 110 DAS (63.27).

(iv) Pod yield

A steep and almost steady increase in the parameter was recorded between 70 and 90 DAS. Delay in the time of harvest beyond 90 DAS however resulted in a gradual decline in the pod yield. The peak performance, for this parameter was recorded at 90 DAS (12.85 g).

(v) 100 pod weight

A slow increase followed by a spurt in the value of this parameter was registered between 70 and 90 DAS. 100 pod weight recorded the maximum value at the third harvest (88.58 g). However it registered significantly lower values in the last two harvests.

Further delay in the time of harvest resulted in a continuous decline in the value of this parameter. It was however noticed that the yield of haulms at 90 DAS and 100 DAS were statistically on par.

(x) Harvest Index

The parameter showed increase in value from 70 to 90 DAS and declined thereafter. It showed a rapid increase from 80 to 90 DAS. The peak value was recorded at 90 DAS (0.20).

(xi) Oil percentage

The genotype registered a continuous increase in the oil percentage from 70 to 110 DAS registering the highest value (46.95) at the final harvest. However, fairly high values for the parameter were also obtained at 90 DAS (44.30) and 100 DAS (46.10).

4.2.7 ICGS(E) 121

The mean data on the interactions for this genotype are presented in table 6 and illustrated in figure 7.

(1) Height of plant

The genotype showed an increase in plant height between 70 and 90 DAS, after which there occurred no significant change to this parameter till the final harvest. It recorded the maximum value at 90 DAS (56.13).

Table 6. Interaction of genotypes (g_7, g_8 and g_9) with time of harvest

Genotypes X days of harvest	Height of plant (cm)	Number of mature pods	Percent-age of mature pods*	Pod yield (g/plant)	100 pod weight (g)	100 kernal weight (g)	Shelling percent-age (%)	S&K percent-age (%)	Haulms yield (g/plant)	Harvest Index	Oil percent-age (%)
g_7(ICGS(E)121)											
70 DAS	50.35	8.08	56.91	4.68	84.95	36.53	57.19	50.24	60.30	0.13	34.40
80 DAS	53.15	12.00	53.31	9.88	82.08	35.29	55.60	57.09	71.33	0.16	41.15
90 DAS	56.13	13.88	58.67	11.92	88.83	38.20	58.28	62.09	67.23	0.21	44.50
100 DAS	56.00	14.05	60.75	11.22	82.93	35.66	57.19	61.61	65.33	0.21	46.05
110 DAS	55.98	13.95	62.89	10.51	76.40	32.85	57.08	60.55	63.18	0.20	47.55
g_8(Dh(E)20)											
70 DAS	52.35	7.03	55.89	4.08	75.21	30.08	56.29	55.15	55.35	0.14	31.15
80 DAS	55.70	8.85	53.23	6.05	71.30	28.52	54.76	59.93	67.38	0.14	41.60
90 DAS	61.00	13.13	58.24	10.90	78.65	31.46	59.82	67.45	65.23	0.20	42.50
100 DAS	61.03	13.15	60.12	10.41	74.33	29.73	57.07	65.63	64.57	0.20	44.10
110 DAS	61.00	13.75	63.11	9.21	70.13	28.05	58.04	64.79	60.18	0.19	45.25
g_9(Dh(E)32)											
70 DAS	50.38	7.05	58.62	4.53	74.51	30.55	57.49	60.20	59.43	0.14	32.10
80 DAS	57.55	8.40	52.25	6.08	69.25	28.30	56.29	57.94	68.38	0.14	[illegible]
90 DAS	61.20	13.88	60.29	11.15	76.77	31.48	59.87	68.05	64.38	0.21	42.35
100 DAS	61.25	14.08	63.18	10.27	71.98	29.51	59.18	64.11	63.01	0.22	43.40
110 DAS	61.18	14.05	64.53	8.33	68.53	28.01	60.40	63.17	58.32	0.21	44.00
$F_{(56, 210)}$	5.49**	7.05**	150.21**	43.06**	97.15**	44.31**	25.73**	71.53**	11.53**	96.87**	144.17**
SE(gn) ±	0.670	0.390	0.311	0.251	1.003	0.519	0.548	0.442	1.225	0.002	0.106
CD(0.05)	1.220	0.867	0.596	0.485	1.658	0.876	0.959	0.794	2.268	0.004	0.202
cv(gh)	1.268	3.304	0.569	2.727	1.326	1.364	0.968	0.702	1.725	1.082	0.250

* Arc- sine transformed values

** Significant at 1% level.

g - genotypes

h - days of harvest

KEY

•- - - -• NUMBER OF MATURE PODS

o———o POD YIELD

o- - - -o PERCENTAGE OF MATURE PODS

•———• 100 POD WEIGHT

o- - - -o 100 KERNEL WEIGHT

o———o SOUND MATURE KERNEL PERCENTAGE

o———o SHELLING PERCENTAGE

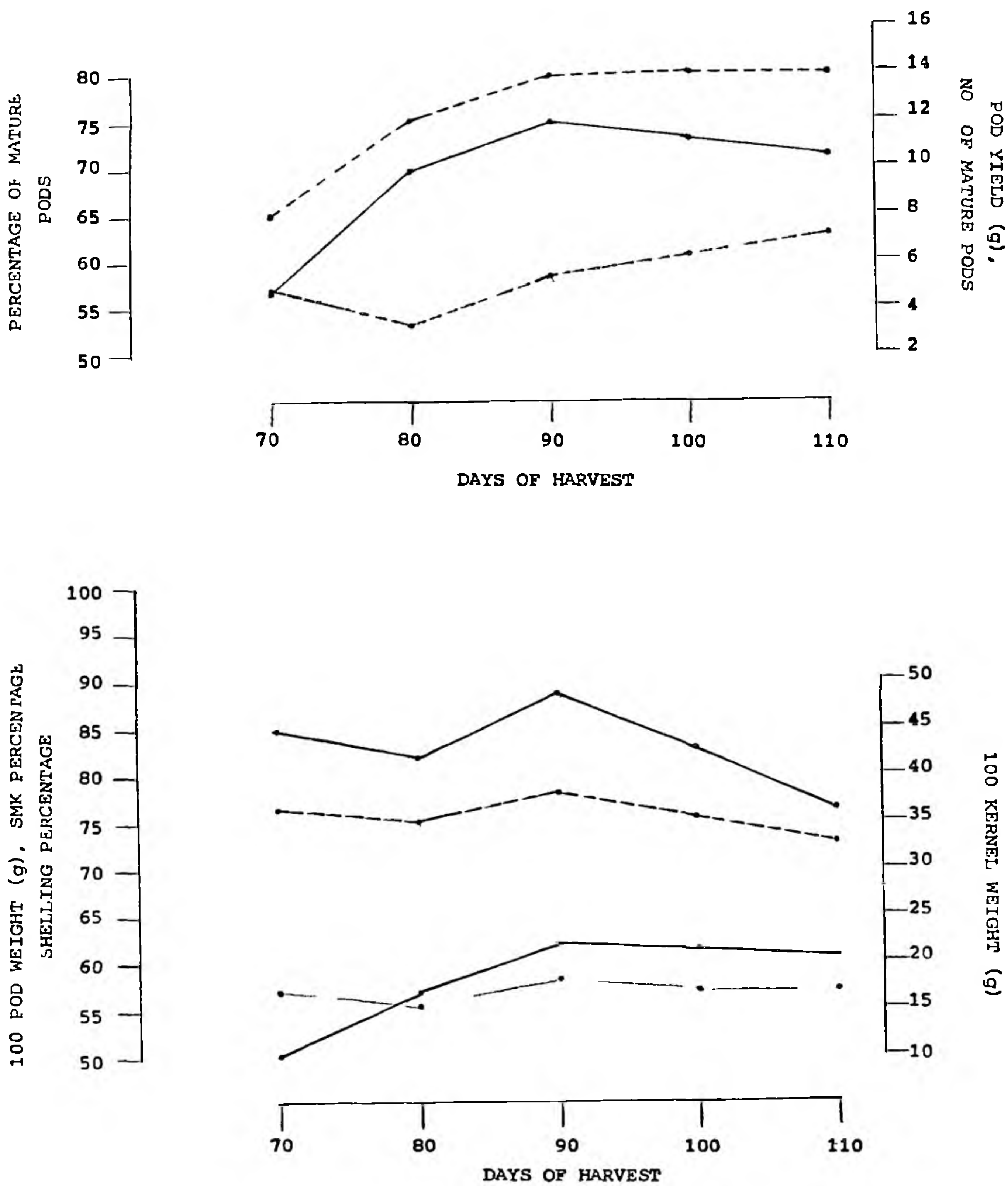

Fig. 7. Effect of staggered harvests on yield and component characters of the genotype ICGS (E) 121.

(ii) Number of mature pods

This parameter recorded an increase in value between 70 and 90 DAS. At 90 DAS, it recorded a value of 13.88. No significant change was effected to this parameter by the fourth and final harvests, eventhough the maximum value was attained at 100 DAS (14.05).

(iii) Percentage of mature pods

The genotype registered a significant declining trend with regard to this parameter between 70 and 80 DAS. But it achieved significant increases with each harvest interval from 80 to 110 DAS. It was noted that the increase was at a faster rate between the second and third harvests. The maximum value for this parameter was recorded (62.89) at the final harvest.

(iv) Pod yield

Pod yield recorded a more or less similar pattern of variation as of number of mature pods between 70 and 90 DAS, with an initial rapid increase followed by a gradual increase. It attained a peak value (11.92 g) at 90 DAS. Beyond 90 DAS, the parameter showed a significant decline in its value.

(v) 100 pod weight

This character showed a significant decline between 70 and 80 DAS. Thereafter it increased in value and attained a maximum (88.83 g) at 90 DAS. This was again followed by a declining trend upto the final harvest.

(vi) 100 kernel weight

The genotype registered a more or less similar pattern of variation for 100 kernel weight as for 100 pod weight, with regard to the time of harvest. The parameter recorded the maximum value (38.20 g) at 90 DAS.

(vii) Shelling percentage

The shelling percentage for the genotype followed a zigzag pattern of variation from the first to the final harvest. It showed an initial decline in value followed by an increase between 70 and 90 DAS. The maximum value was registered at 90 DAS (58.28). Beyond 90 DAS the value of this parameter show a gradual declining trend.

(viii) Sound mature kernel percentage

This parameter recorded a more or less linear and steep increase between 70 and 90 DAS, recording the maximum value (62.09) at 90 DAS. Further delay in the time of harvest however resulted in a gradual decline in this parameter till the final harvest. Statistical analysis indicated that its value at 90 and 100 DAS were on par.

(ix) Haulms yield

The genotype exhibited a rapid increase in the haulms yield when the time of harvest was delayed from 70 to 80 DAS. It recorded a maximum value (71.33 g) at 80 DAS and gradually declined in the subsequent harvest intervals. It was however noted that the value of this parameter at 90 DAS was on par with that at 100 DAS.

(x) Harvest Index

Harvest index recorded an increasing trend between 70 and 90 DAS. It recorded a maximum (0.21) at 90 DAS. The value kept steady till the fourth harvest and then declined.

(xi) Oil percentage

The genotype registered a continuous increase in this parameter from the first to the final harvest. It recorded the maximum (47.55) at 110 DAS. However fairly high values were also obtained at 90 DAS (44.50) and 100 DAS (46.05).

4.2.8 Dh(E)20

The mean data on the interactions of this genotype are presented in table 6 and figure 8.

(i) Height of plant

The parameter increased with delay in the time of harvest from 70 to 90 DAS and attained the peak value (61.00 cm) at 90 DAS. Thereafter the parameter did not show any significant variation with regard to the time of harvest, eventhough the harvest at 100 DAS showed the maximum plant height (61.03 cm).

(ii) Number of mature pods

This character registered a slower rate of increase between 70 and 80 DAS, followed by a rapid increase and recorded a value of 13.13 at 90 DAS. Further delay in the time of harvest imparted only a marginal and statistically non-significant increase to this parameter. The maximum value, however, was recorded at 110 DAS (13.75).

(iii) Percentage of mature pods

After an initial decline between 70 and 80 DAS, the value of this parameter registered continuous increase with regard to the time of harvest and attained the peak value (63.11) at 110 DAS.

KEY

NUMBER OF MATURE PODS

POD YIELD

PERCENTAGE OF MATURE PODS

100 POD WEIGHT

100 KERNEL WEIGHT

SOUND MATURE KERNEL PERCENTAGE

SHELLING PERCENTAGE

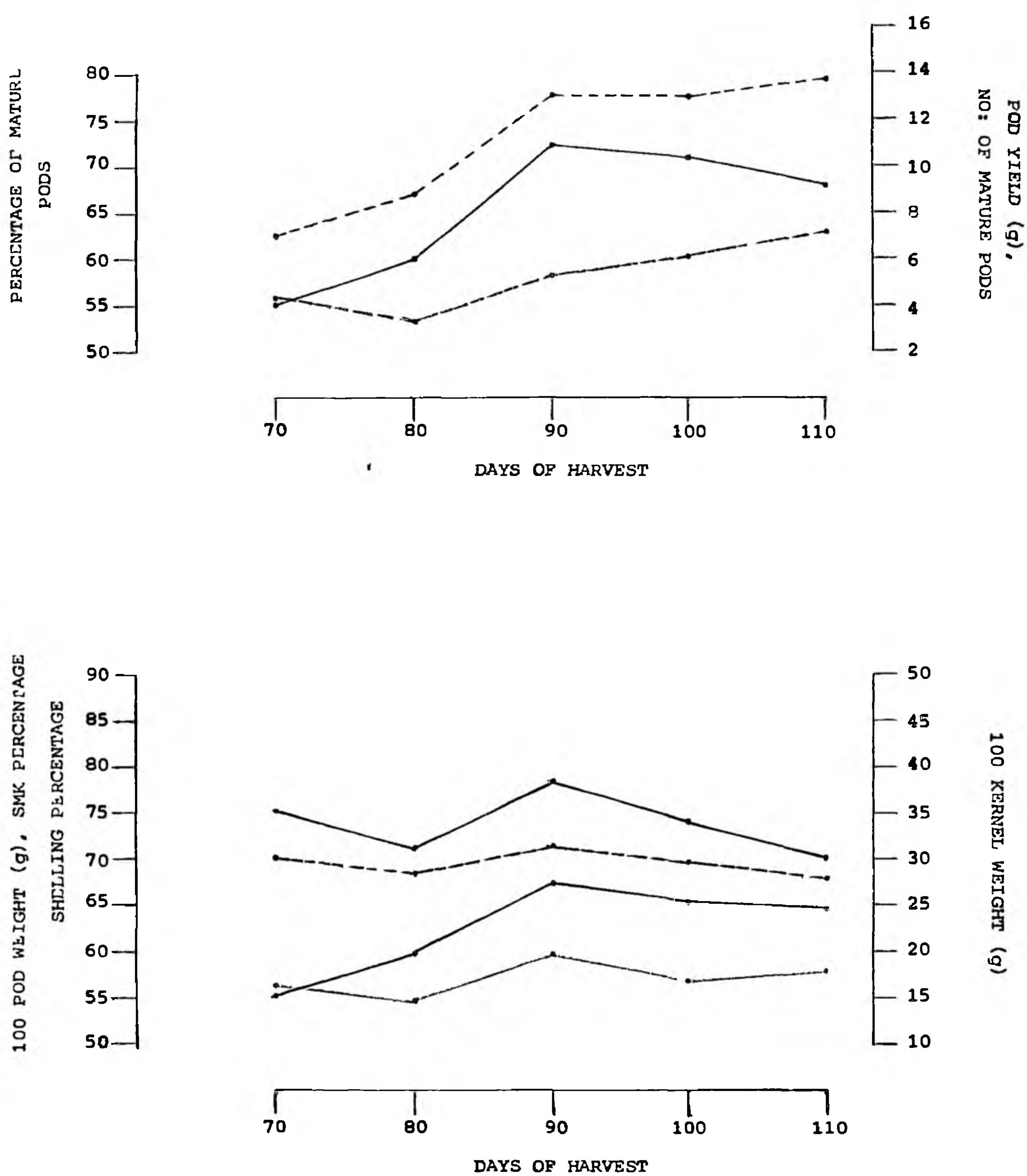

Fig.8. Effect of staggered harvests on yield and component characters of the genotype Dh(E) 20.

(iv) Pod yield

The pod yield showed appreciable increase with delay in the time of harvest from 70 to 90 DAS. It recorded a peak value (10.90 g) at 90 DAS. Thereafter it gradually declined in value till the final harvest.

(v) 100 pod weight

The harvest interval between 70 and 80 DAS witnessed a significant decline in the value of this parameter. Thereafter it gained magnitude and recorded a maximum value (78.65 g) at 90 DAS. Further delay in the time of harvest, however, caused significant decline in the value of this parameter till the final harvest.

(vi) 100 kernel weight

This parameter also followed a more or less similar pattern of variation as 100 pod weight between 70 and 110 DAS. In this course it recorded the peak value (31.46 g), also at 90 DAS.

(vii) Shelling percentage

The genotype registered a zigzag pattern of variation for shelling percentage. The parameter recorded an initial decline followed by an increase to record a peak (59.82) at 90 DAS. It again declined in value during the next harvest interval and further revived gradually during the final harvest interval. The trend expressed by the parameter from 70 to 100 DAS was roughly similar to that of 100 pod weight and 100 kernel weight.

(viii) Sound mature kernel percentage

This parameter recorded an initial slow increase followed by a rapid increase, to attain a peak value (67.45) at 90 DAS. However harvests at 100 DAS and 110 DAS registered significant reduction in the value of this parameter.

(ix) Haulms yield

The yield of haulms showed an appreciable increase between the first two harvests and registered the maximum value (67.38 g) at 80 DAS. The last three harvests recorded continuous decline in the value of this parameter. However, its performance at 90 DAS and 100 DAS were statistically on par.

(x) Harvest index

The genotype registered a steady value for harvest index between 70 and 80 DAS followed by an increase to record a maximum (0.20) at 90 DAS. The value kept steady till 100 DAS and declined thereafter.

(xi) Oil percentage

This parameter exhibited a continuous increase in value from 70 to 110 DAS. It registered a maximum value (45.25) at the final harvest. However fairly high values were also obtained for this parameter at 90 DAS (42.50) and 100 DAS (44.10).

4.2.9 Dh(E) 32

The mean data on the interactions for this genotype are presented in table 6 and illustrated in figure 9.

(i) Height of plant

The genotype registered a significant increase in plant height with delay in time of harvest from 70 to 90 DAS. The last two harvests did not produce any significant effect on this parameter. It recorded the maximum value (61.25cm) at 100 DAS. However this was statistically on par with the plant height recorded at 90 DAS (61.20 cm).

(ii) Number of mature pods

This character showed a gradual increase followed by a rapid increase when the time of harvest was delayed from 70 to 90 DAS. Thereafter it showed only a non-significant increase to record a maximum value (14.08) at 100 DAS. This however was on par with the value at 90 DAS (13.88).

(iii) Percentage of mature pods

The parameter registered a significant decline in value from 70 to 80 DAS after which it progressively

KEY

NUMBER OF MATURE PODS

POD YIELD

PERCENTAGE OF MATURE PODS

100 POD WEIGHT

100 KERNEL WEIGHT

SOUND MATURE KERNEL PERCENTAGE

SHELLING PERCENTAGE

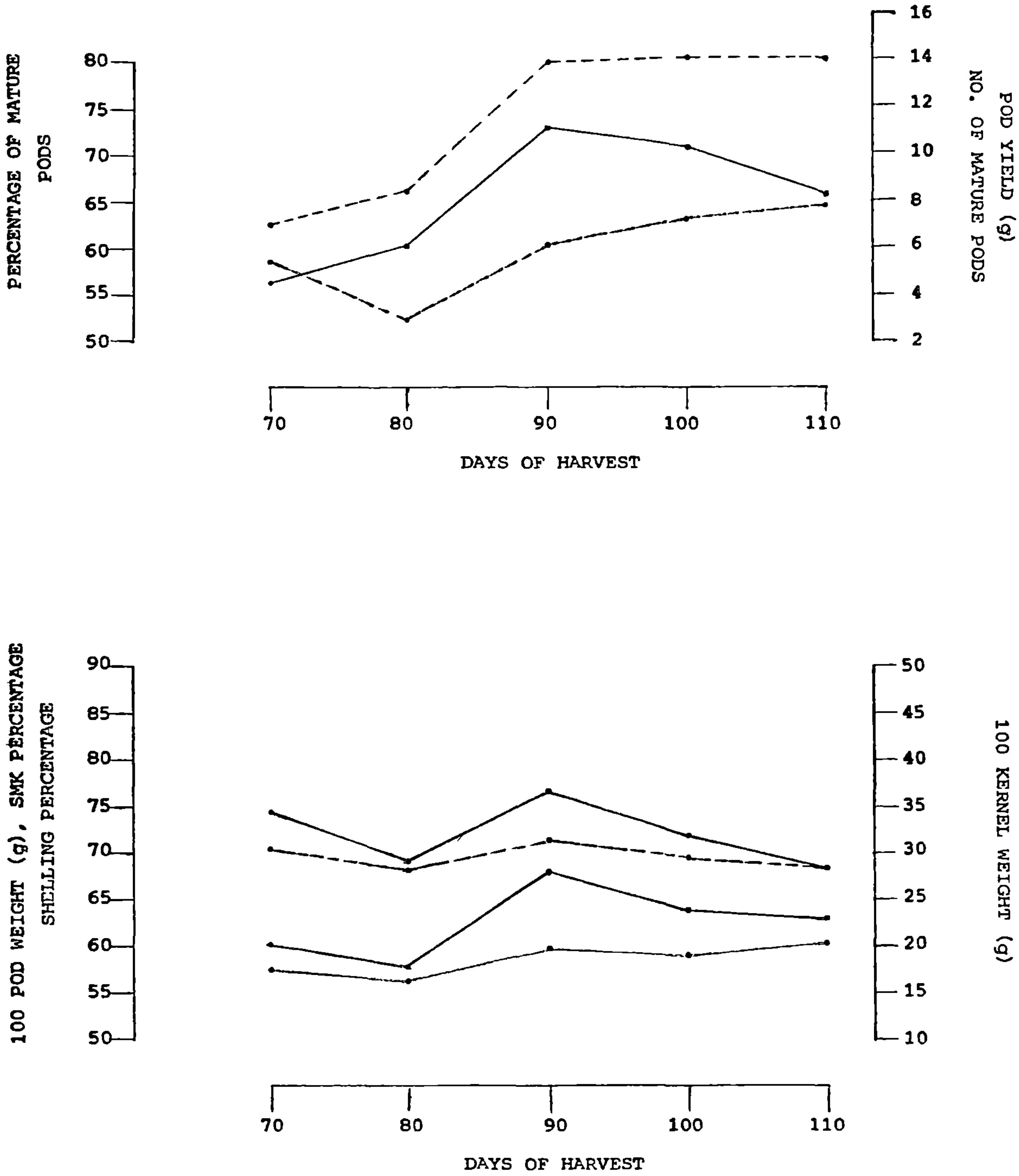

Fig. 9. Effect of staggered harvests on yield and component characters of the genotype Dh(E) 32.

increased in magnitude till the final harvest. There occurred a rapid increase between 80 and 90 DAS, followed by a gradual increase during the last two harvest intervals. It recorded a maximum value (64.53) at the final harvest.

(iv) Pod yield

The genotype registered an initial gradual increase followed by a rapid increase in the magnitude of this parameter, when the time of harvest was delayed from 70 to 90 DAS. Further delay in the time of harvest however, caused significant reduction in the pod yield till 110 DAS. A maximum pod yield was recorded at 90 DAS (11.15 g).

(v) 100 pod weight

From 70 to 90 DAS, this parameter followed a more or less similar pattern of variation as percentage of mature pods, showing an initial decline in magnitude, followed by a rapid increase. Harvests beyond 90 DAS, however resulted in significant reduction in the value of this parameter. Maximum value for 100 pod weight (76.77 g) was obtained at the third harvest.

(vi) 100 kernel weight

This parameter followed a more or less similar pattern of variation as 100 pod weight. It also recorded the peak value at 90 DAS (31.48 g).

(vii) Shelling percentage

This genotype also expressed a zigzag pattern of variation for this parameter. It registered an initial decline between 70 and 80 DAS, followed by an increase in value during the subsequent harvest interval. A more or less similar trend was repeated by the parameter between 90 and 110 DAS. It attained maximum value at 110 DAS (60.40). However statistical analysis indicate that this value was on par with that obtained at 90 DAS (59.87).

(viii) Sound mature kernel percentage

Between 70 and 90 DAS, the parameter showed an initial decline followed by a rapid increase to reach a maximum value (68.05) at the third harvest. It further declined with each succeeding harvest till 110 DAS.

(ix) Haulms yield

Extending the time of harvest from 70 to 80 DAS increased the yield of haulms to a peak value of (68.38 g). From the second to the final harvest the value of this parameter declined progressively. However it recorded on par values at 90 and 100 DAS.

(x) Harvest index

The parameter kept steady during the first harvest interval. Between 80 and 100 DAS it gained magnitude and recorded the peak value (0.22) at 100 DAS. Further delay in the time of harvest significantly reduced the value of this parameter.

(xi) Oil percentage

This parameter registered continuous increase in value from the first to the final harvest. The genotype recorded maximum value for this trait at 110 DAS (44.00). However fairly high values were also obtained at 90 DAS (42.35) and 100 DAS (43.40).

4.2.10 BPG 521

The mean data on the interactions of this genotype are presented in table 7 and illustrated in figure 10.

(i) Height of plant

The genotype recorded a significant increase in value for this parameter between 70 and 90 DAS. It recorded a plant height of 59.95 cm at the third harvest (90 DAS). Further delay in the harvest time however did

Table 7. Interaction of genotypes (g_{10}, g_{11} and g_{12}) with time of harvest

Genotypes X days of harvest	Height of plant (cm)	Number of mature pods	* Percentage of mature pods	Pod yield (g/plant)	100 pod weight (g)	100 kernal weight (g)	* Shelling percentage (%)	* SMK percentage (%)	Haulms yield (g/plant)	Harvest Index	Oil percentage (%)
g_{10}(BPG 521)											
70 DAS	44.97	4.15	48.04	2.10	74.33	31.21	54.15	57.59	59.16	0.14	36.15
80 DAS	57.03	7.43	50.85	4.10	76.13	31.90	55.70	60.20	67 75	0.16	39.90
90 DAS	59.95	9.40	58.37	8.35	87.13	36.59	58.59	65.68	74.33	0 18	42 15
100 DAS	60.03	11.05	62.21	11.92	100.35	42.15	60.88	67.89	69.28	0.21	46.10
110 DAS	59.95	11.28	64.15	11.32	91.17	38.29	59.90	63.57	67.52	0.21	47.15
g_{11}(JL-24)@											
70 DAS	55.82	5.28	54.59	4.00	70.19	30.18	48.60	56.49	59.28	0.15	33.00
80 DAS	57.80	7.79	55.57	7.10	76.78	32.25	59.32	59.24	71.83	0.17	38.50
90 DAS	61.35	9.99	58.37	10.91	89.95	37.78	58.42	63.43	84.33	0.18	43 05
100 DAS	61.43	11.05	62.06	13.03	110.00	47.32	65.01	71.40	78 08	0 22	45.15
110 DAS	61.43	11.17	65.01	12.40	105.33	45.29	69.52	67.50	76 98	0.23	47 95
g_{12}(TMV-2)											
70 DAS	52.03	5.08	54.25	3.98	65.93	28.00	45.30	58.22	65.38	0.15	35.35
80 DAS	58.55	9.20	54 36	6 08	72.30	31.01	56.68	60.99	75.83	0.15	43.50
90 DAS	65.50	12.00	59.12	8.99	80.35	34.55	55.60	64 89	87 38	0 17	44.60
100 DAS	65.58	13.25	62.39	13.40	98.10	42 18	61 72	69 98	83 23	0 20	45.20
110 DAS	65.60	13.08	64.09	11.60	92.92	39.96	65.52	67 82	82 35	0.21	47.15
F(56,210)	5.49**	7.05**	150.21**	43.06**	97.15**	44 31**	25.73**	71 53**	11 53**	96.87**	144.17**
SE(gh) ±	0.670	0.390	0.311	0.251	1.003	0.519	0.548	0.442	1.225	0 002	0.106
CD(0.05)	1.220	0.867	0.596	0.485	1.658	0.876	0 959	0.794	2 208	0.004	0.202
cv(gh)	1 268	3.304	0.569	2.727	1.326	1.364	0.968	0.707	1.725	1 082	0.250

* Arc-sine transformed values

** Significant at 1% level.

@ Yield check.

g - genotypes

h - days of harvest

KEY

- - - - NUMBER OF MATURE PODS

——— POD YIELD

- - - - PERCENTAGE OF MATURE PODS

——— 100 POD WEIGHT

- - - - 100 KERNEL WEIGHT

——— SOUND MATURE KERNEL PERCENTAGE

——— SHELLING PERCENTAGE

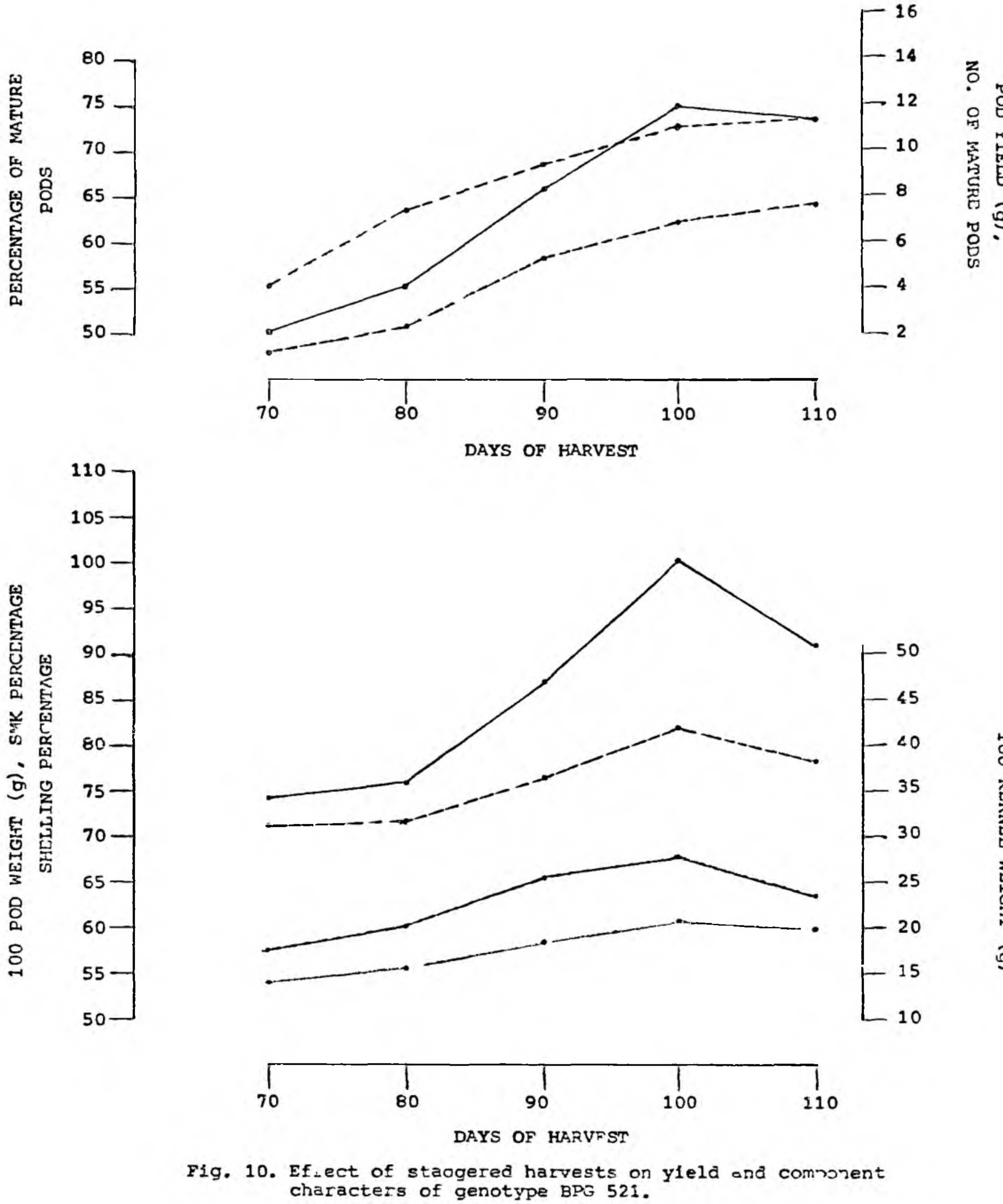

Fig. 10. Effect of staggered harvests on yield and component characters of genotype BPG 521.

not result in any significant change for this parameter. However, the parameter recorded its maximum value at 100 DAS (60.03 cm).

(ii) Number of mature pods

This character showed an increasing trend with delay in the time of harvest upto 110 DAS. The increase in the value of this parameter started at a faster rate which gradually slowed down with the succeeding harvest intervals and finally attained a maximum value at the final harvest (11.28). Statistical analysis however suggested that this was on par with the value obtained at 100 DAS (11.05).

(iii) Percentage of mature pods

This parameter also showed a continuous increase in value with respect to days of harvest from 70 to 110 DAS. It registered a comparatively faster rate of increase between 80 and 90 DAS. Maximum performance for this character was realised at the final harvest (64.15). It however registered a fairly high value (62.21) at 100 DAS also.

(iv) Pod yield

The genotype registered an initial slow increase for this parameter followed by appreciable high increases during the second and third harvest intervals. It recorded a peak value (11.92 g) at 100 DAS, after which the value declined significantly.

(v) 100 pod weight

The parameter showed an initial slow increase between the first two harvest dates, followed by remarkably high increase in the third and fourth harvests It registered a peak value at the fourth harvest (100.35 g). The final harvest however witnessed a significant decline for this parameter.

(vi) 100 kernel weight

This too followed a more or less similar pattern of variation as 100 pod weight and pod yield. It also registered its peak value at 100 DAS (42.15 g).

(vii) Shelling percentage

This parameter recorded a more or less steady and gradual increase from 70 to 100 DAS, recording a peak value (60.88) at the fourth harvest. The final harvest however registered a decline in the value of this parameter.

(viii) Sound mature kernel percentage

The parameter showed continuous increase in value from the first to the fourth harvest. It recorded the peak performance at 100 DAS (67.89). The final harvest exhibited a reduction in the percentage of sound mature kernels. There occurred a comparative faster rate of increase for the parameter between 80 and 90 DAS.

(ix) Haulms yield

This parameter exhibited a rapidly increasing trend with delay in the days of harvest from 70 to 90 DAS. It recorded the peak value (74.33 g) at 90 DAS and declined in value in both the later harvests. It was however noticed that the value recorded at 100 and 110 DAS were statistically on par with each other.

(x) Harvest index

Delay in the time of harvest caused a continuous and more or less steady increase in the value of this parameter upto 100 DAS. It recorded the maximum value in the fourth harvest (0.21). The value however kept steady till the final harvest.

(xi) Oil percentage

The genotype recorded a continuous increase in the oil percentage from the first to the last harvest. The maximum oil percentage was registered at 110 DAS (47.15). However a fairly high value for this parameter was also recorded at 100 DAS (46.10).

4.2.11 JL 24 (Yield check)

The mean data on the interactions of this genotype are presented in table 7 and illustrated in figure 11.

(i) Height of plant

The genotype registered continuous increase for this character from 70 to 100 DAS. The maximum value for this character (61.43 cm) was attained at 100 DAS. Statistical analysis however showed that this was on par with the value recorded at 90 DAS (61.35 cm).

(ii) Number of mature pods

The value of this parameter increased continuously with delay in the time of harvest from 70 to 100 DAS. At 100 DAS it recorded a value of 11.05. The final harvest exhibited a further non-significant increase for the parameter, to record the maximum value (11.17).

(iii) Percentage of mature pods

This parameter exhibited a gradual increase from 70 to 110 DAS. The genotype recorded the maximum value for this parameter at the final harvest (65.01).

(iv) Pod yield

The pod yield recorded a more or less steady increase between the first and fourth harvest dates.

KEY

- NUMBER OF MATURE PODS
- POD YIELD
- PERCENTAGE OF MATURE PODS

- 100 POD WEIGHT
- 100 KERNEL WEIGHT
- SOUND MATURE KERNEL PERCENTAGE
- SHELLING PERCENTAGE

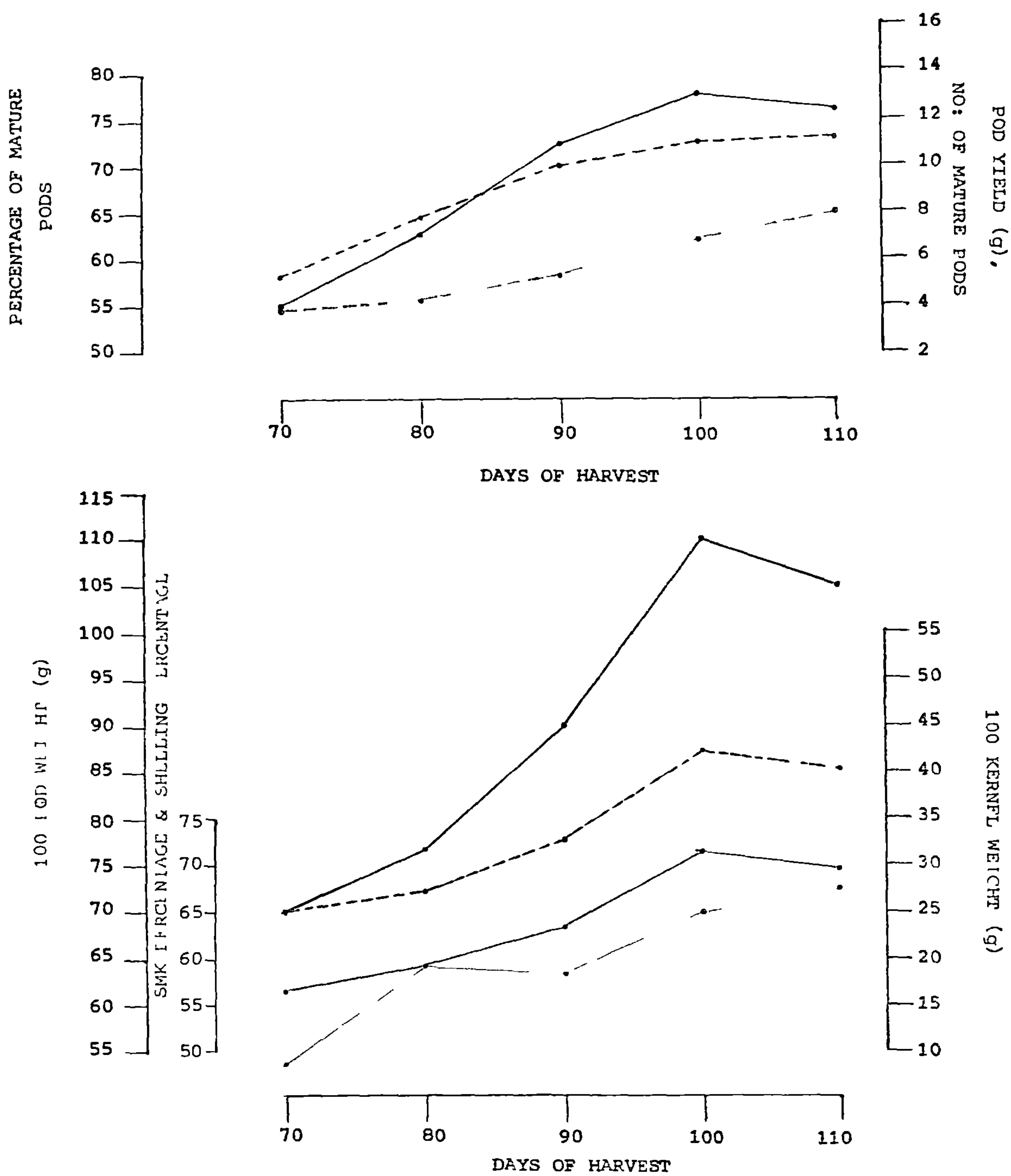

Fig. 11. Effect of staggered harvests on yield and component characters of the genotype JL 24.

It recorded a peak value at 100 DAS (13.03 g). The final harvest however recorded a decline in the value of this parameter.

(v) 100 pod weight

This parameter registered an initial slow increase in value during the first harvest interval, followed by rapid spurts in value during the second and third harvest intervals. The final harvest interval however witnessed a significant decline for this parameter. The peak value (110.00 g) was recorded at 100 DAS.

(vi) 100 kernel weight

This parameter also registered a more or less similar pattern of variation as in the case of 100 pod weight. The genotype recorded the maximum value for this parameter also at 100 DAS (47.32 g).

(vii) Shelling percentage

The genotype recorded an irregular pattern of variation for this parameter in relation to the time of harvest from 70 to 110 DAS. It registered a rapid increase between the first two harvests, followed by a marginal non-significant decline till 90 DAS. The parameter, however gained in magnitude during the last two harvest intervals and recorded a maximum value (69.52) at 110 DAS.

(viii) Sound mature kernel percentage

This parameter registered a gradual increase in value from 70 to 90 DAS, after which it increased at a faster rate to record a maximum (71.40) at 100 DAS. Further delay in harvesting however resulted in significant decline of this parameter.

(ix) Haulms yield

This parameter recorded a steady and steep increase between 70 and 90 DAS, after which it declined with respect to the time of harvest. The genotype recorded peak haulms yield at 90 DAS (84.33 g). It was however noticed that the values recorded at 100 DAS and 110 DAS were statistically on par.

(x) Harvest index

This parameter showed continuous increase in value from 70 to 110 DAS, however at varying rates. It registered an initial rapid increase between 70 and 80 DAS, followed by a slow increase upto 90 DAS. Between 90 and 100 DAS it registered a spurt in value. The parameter further increased in value beyond 100 DAS to record the maximum value at the final harvest (0.23).

(xi) Oil percentage

The genotype registered a continuous increase in the percentage of oil from the first to the final harvest. It registered a rapid rate of increase upto 90 DAS, followed by a slower rate of increase and recorded a maximum value (47.95) at 110 DAS.

4.2.12 TMV 2

The mean data on the interactions of this parameter are presented in table 7 and figure 12.

(i) Height of plant

The genotype registered a continuous increase in the value of this parameter from 70 to 90 DAS beyond which the character did not show any further significant change in value. The genotype registered maximum plant height (65.60 cm) at 110 DAS. However statistical analysis indicated that this was on par with the value obtained at 90 and 100 DAS.

(ii) Number of mature pods

The character showed an increasing trend with delay in the time of harvest, upto 100 DAS. The increase in value of this parameter started at a faster rate which gradually slowed down with each successive harvest interval and finally attained a maximum value at 100 DAS (13.25). The parameter however did not register any significant change in the final harvest.

KEY

NUMBER OF MATURE PODS

POD YIELD

PERCENTAGE OF MATURE PODS

100 POD WEIGHT

100 KERNEL WEIGHT

SOUND MATURE KERNEL PERCENTAGE

SHELLING PERCENTAGE

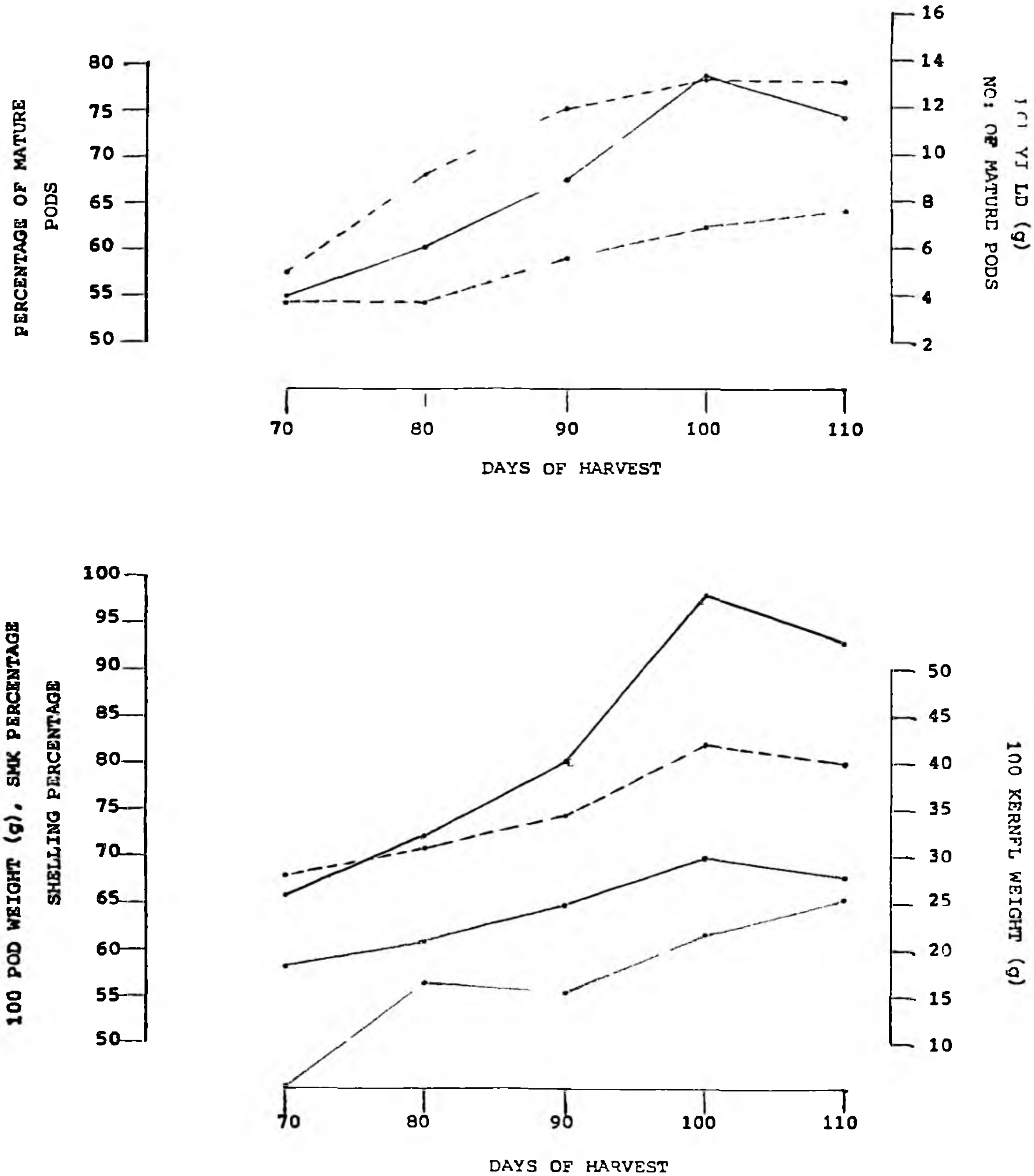

Fig. 12. Effect of staggered harvests on yield and component characters of the genotype TMV 2.

(iii) Percentage of mature pods

The parameter kept steady during the first harvest interval, after which it increased almost steadily with each successive harvest interval and recorded a maximum value (64.09) at the final harvest.

(iv) Pod yield

The parameter recorded continuous increase with successive harvest interval from 70 to 100 DAS. The rate of increase of this parameter enhanced after each harvest interval until a peak value (13.40 g) was registered at 100 DAS. The final harvest however indicated a significant decline in pod yield.

(v) 100 pod weight

The genotype showed a steady increase in the value of this parameter from 70 to 90 DAS, after which there occurred a sudden spurt in value to record a maximum (98.10 g) at 100 DAS. Beyond 100 DAS it showed a significant decline in the value of this parameter.

(vi) 100 kernel weight

This parameter also showed a more or less similar pattern of variation as that of 100 pod weight. It recorded a peak value (42.18 g) at 100 DAS.

(vii) Shelling percentage

The character recorded an irregular pattern of variation with regard to the time of harvest. Between 70 and 80 DAS, there occurred a rapid increase in shelling percentage. This however was followed by a non-significant decline upto 90 DAS. The parameter further gained magnitude between 90 and 110 DAS and recorded the highest value (65.52) at 110 DAS.

(viii) Sound mature kernel percentage

This parameter showed a more or less steady and gradual increase in value from 70 to 100 DAS after which it declined significantly. It recorded maximum value (69.98) at 100 DAS.

(ix) Haulms yield

The genotype registered a rapid, steady increase in haulms yield from the first to the third harvest, after which it exhibited a significant decline in value until the final harvest. It recorded peak haulms yield at 90 DAS (87.38 g). It was however noted that the value obtained at 100 DAS was statistically on par with that at 110 DAS.

(x) Harvest index

The parameter maintained a steady value between the first two harvests. Between the second and the final harvest, its value increased with every succeeding harvest interval to register the maximum value at 110 DAS (0.21).

(xi) Oil percentage

The genotype recorded a continuous increase in this parameter between the first and the last harvest. The maximum value was attained at 110 DAS (47.15). It was however noted that harvest at 100 DAS also gave a fairly high value for this parameter (45.20).

4.2.13 TG 3

The mean data on the interactions for this parameter are presented in table 8 and figure 13.

(i) Height of plant

The height of plant increased continuously between the first and third harvests and recorded a maximum (57.78 cm) at 90 DAS. It however did not show any significant change during the subsequent harvest intervals.

(ii) Number of mature pods

This parameter registered an initial slow increase, followed by a rapid increase and then again a slow

Table 8 Interaction of genotypes- (g_{13}, g_{14} and g_{15}) with time of harvest

Genotype X Days of harvest	Height of plant (cm)	Number of mature pods	* Percent age of mature pods	Pod yield (g/plant)	100 pod weight (g)	100 kernal weight (g)	* Shelling percent age (%)	* SMK percent age (%)	Haulms yield (g/plant)	Harvest Index	Oil percent age ( )
g_{13}(TG-3)	-										
70 DAS	49.48	6.83	50.96	4.15	77.98	33.50	57.19	62.81	69.38	0.14	35.00
80 DAS	54.48	8.23	49.14	6.52	73.40	31.50	50.19	59.30	79.63	0.15	39.70
90 DAS	57.78	11.78	56.12	11.13	90.45	38.99	56.25	66.18	85.33	0.17	42.50
100 DAS	57.73	13.08	60.39	13.03	100.13	43.05	59.58	69.09	82.33	0.20	44.95
110 DAS	57.78	13.33	63.12	12.42	96.23	41.38	64.01	67.59	81.33	0.21	46.60
g_{14}(TG-14)@	-										
70 DAS	53.05	7.20	59.30	4.28	79.20	34.05	58.10	62.51	65.38	0.13	33.05
80 DAS	60.40	8.65	56.91	6.98	75.00	32.20	53.56	57.72	80.30	0.14	40.15
90 DAS	64.53	12.01	59.80	11.76	100.10	43.04	61.10	62.01	89.38	0.17	44.05
100 DAS	64.58	13.88	63.41	14.03	119.28	51.09	60.04	66.02	85.38	0.20	46.45
110 DAS	64.60	13.80	65.53	13.23	110.15	47.36	63.12	61.01	83.25	0.21	48.05
g_{15}(Chico)#	-										
70 DAS	37.63	17.51	58.51	7.98	40.40	17.37	53.28	67.33	60.30	0.17	35.15
80 DAS	39.88	19.77	62.06	10.10	55.48	23.86	57.90	71.93	55.40	0.19	44.15
90 DAS	43.43	19.01	63.02	9.20	53.03	22.80	54.50	68.99	53.80	0.19	46.65
100 DAS	43.45	17.53	58.72	7.85	48.38	20.80	50.35	59.97	48.22	0.21	45.76
110 DAS	43.33	16.91	56.13	6.33	44.63	19.09	45.56	56.17	47.13	0.20	45.08
F(56, 210)	5.49**	7.05**	150.21**	43.06**	97.15**	44.31**	25.73**	71.53**	11.53**	96.87**	144.17**
SE(gh) ±	0.670	0.390	0.311	0.251	1.003	0.519	0.548	0.442	1.225	0.002	0.106
CD(0.05)	1.220	0.8[illegible]7	0.596	0.485	1.658	0.876	0.959	0.794	2.268	0.004	0.202
CV (gh)	1.268	3.304	0.569	2.727	1.326	1.364	0.968	0.707	1.725	1.082	0.250

* Arc-sine transformed values
** Significant at 1% level

@ Yield check
\# duration check

g - genotypes
h - days of harvest

KEY

NUMBER OF MATURE PODS

POD YIELD

PERCENTAGE OF MATURE PODS

100 POD WEIGHT

100 KERNEL WEIGHT

SOUND MATURE KERNEL PERCENTAGE

SHELLING PERCENTAGE

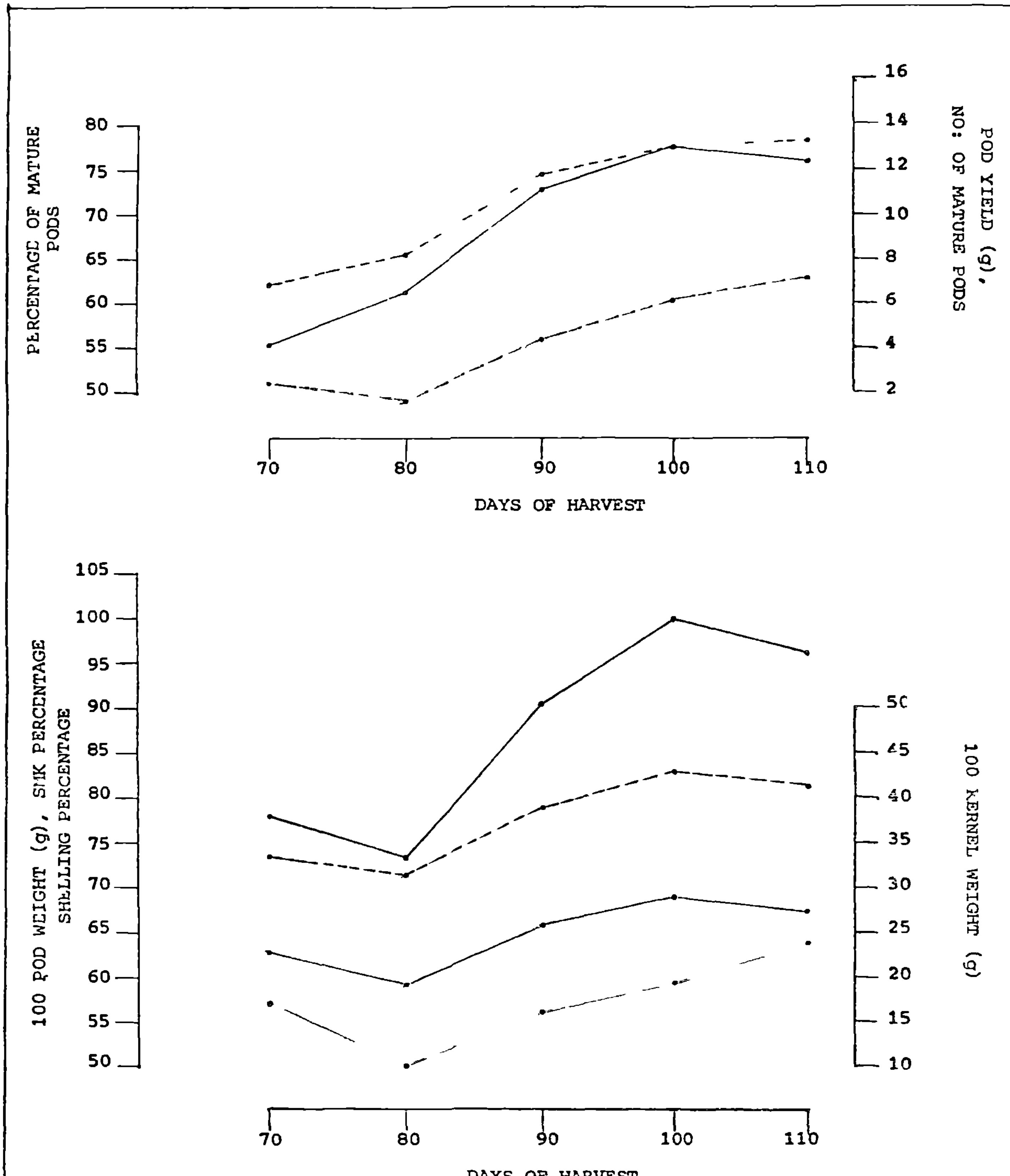

Fig. 13. Effect of staggered harvests on yield and component characters of the genotype TG 3.

increase between 70 and 100 DAS. The maximum number of mature pods (13.33) was registered at 110 DAS. However it was statistically on par with that recorded at 100 DAS (13.08).

(iii) Percentage of mature pods

This parameter showed an initial decline in value, followed by progressive increase during the remaining harvest intervals. Maximum value (63.12) was recorded at the final harvest. It was noted that the parameter increased in value at a comparatively faster rate between 80 and 90 DAS.

(iv) Pod yield

This character followed a more or less similar pattern of variation as number of mature pods with regard to the time of harvest, from 70 to 100 DAS. It increased in value at a comparatively faster rate between 80 and 90 DAS. The peak value was registered at 100 DAS (13.03 g) after which it declined significantly.

(v) 100 pod weight

The parameter followed a more or less similar pattern of variation as pod yield between 80 and 110 DAS. An initial decline in the value of this parameter from the first to the second harvest was followed by steep increases during the subsequent two harvest intervals.

Peak value for the parameter was registered at 100 DAS (100.13 g). Further delay in the time of harvest resulted in significant reduction in the value of the parameter for the genotype. Increase in value between 80 and 90 DAS was at a comparatively faster rate.

(vi) 100 kernel weight

This parameter also followed a more or less similar trend as the 100 pod weight. It registered its peak value also at 100 DAS (43.05 g).

(vii) Shelling percentage

This parameter followed a more or less similar pattern of variation as 100 pod weight and 100 kernel weight, between 70 and 100 DAS. However unlike these characters, the shelling percentage increased beyond 100 DAS to record a maximum value (64.01) at 110 DAS.

(viii) Sound mature kernel percentage

This character followed a more or less similar pattern of variation as the 100 pod weight and 100 kernel weight from 70 to 110 DAS. It recorded the peak value, also at 100 DAS (69.09).

(ix) Haulms yield

There was a progressive increase in the yield of haulms with respect to the time of harvest from 70 to

90 DAS. It attained a peak value (85.33 g) at the third harvest and thereafter continuously decreased in value with regard to the days of harvest. It was however noted that the increase in value of this parameter took place at a comparatively faster rate from 70 to 80 DAS. Moreover the value recorded at 100 DAS was statistically on par with that recorded at 110 DAS.

(x) Harvest index

The parameter showed a progressive increase in value from the first to the last harvest. The maximum value for the parameter (0.21) was attained at 110 DAS.

(xi) Oil percentage

The oil percentage of the genotype also exhibited a progressive increase in value from the first to the final harvest. It recorded the highest value (46.60) at 110 DAS. However a fairly high value (44.95) was registered at 100 DAS.

4.2.14 TG 14 (Yield check)

The mean data on the interactions for this genotype are given in table 8 and illustrated in figure 14.

KEY

NUMBER OF MATURE PODS

POD YIELD

PERCENTAGE OF MATURE PODS

100 POD WEIGHT

100 KERNEL WEIGHT

SOUND MATURE KERNEL PERCENTAGE

SHELLING PERCENTAGE

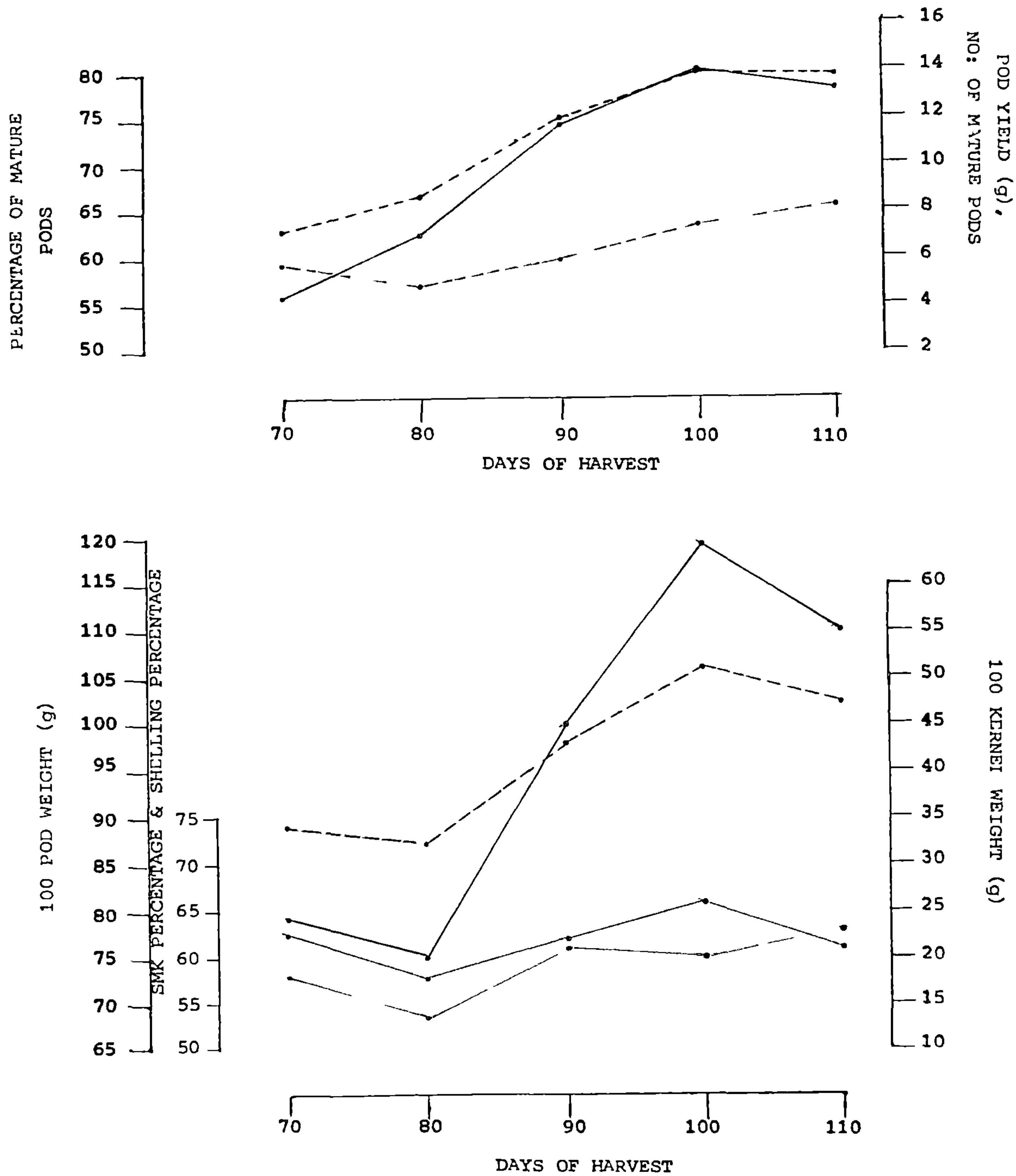

Fig.14. Effect of staggered harvests on yield and component characters of the genotype TG 14.

(i) Height of plant

The plant height recorded continuous increase in value from 70 to 90 DAS. It recorded a value of 64.53 cm at 90 DAS, after which no significant change occurred to this parameter. However it recorded the highest value (64.60 cm) at 110 DAS.

(ii) Number of mature pods

This parameter registered a progressive increase in value from 70 to 100 DAS. The rate of increase showed a comparatively higher value during the second harvest interval (80 to 90 DAS). The parameter recorded the highest value at 100 DAS (13.88) after which it did not exhibit any further significant change.

(iii) Percentage of mature pods

The value of this parameter showed an initial decline from 70 to 80 DAS after which it increased progressively upto the final harvest when the maximum value (65.53) was recorded. There occurred a steady and comparatively faster rate of increase between 80 and 100 DAS.

(iv) Pod yield

The pod yield also followed a more or less similar pattern of variation as the number of mature pods from

70 to 100 DAS. Beyond 100 DAS, however, the parameter showed significant decline in its value. Peak value of pod yield for the genotype was recorded at 100 DAS (14.03 g).

(v) 100 pod weight

There occurred an initial decline in the value of 100 pod weight between 70 and 80 DAS, whereafter it showed a sudden spurt to record the top value (119.28 g) at 100 DAS. The final harvest however indicated a significant decline in this parameter.

(vi) 100 kernel weight

This parameter also registered a more or less similar pattern of variation as 100 pod weight and recorded the peak value (51.09 g) at 100 DAS.

(vii) Shelling percentage

The genotype recorded a zigzag pattern of variation for this parameter. It recorded an initial decline in value between 70 and 80 DAS, followed by an appreciable increase upto 90 DAS. The parameter further registered a non-significant decline in value followed by a rise during the final harvest interval to record the maximum (63.12) at 110 DAS.

(viii) Sound mature kernel percentage

This parameter registered a more or less similar pattern of variation as 100 pod weight and 100 kernel weight with regard to the time of harvest from 70 to 110 DAS. It attained its peak value (66.02) in the fourth harvest.

(ix) Haulms yield

The parameter registered a progressive steep increase in value from 70 to 90 DAS, after which it decline significantly in value with respect to the time of harvest. The peak value for this parameter was attained at 90 DAS (89.38 g). It was also observed that the values for this parameter recorded at 100 and 110 DAS were statistically on par with each other.

(x) Harvest index

This parameter showed progressive increase in value from the first to the final harvest. It recorded the highest value (0.21) at 110 DAS.

(xi) Oil percentage

This parameter also showed progressive increase in value from the first to the last harvest. It attained peak value (48.05) at 110 DAS. However a fairly high value was also obtained at 100 DAS (46.45).

4.2.15 Chico (duration check)

The mean data on the interactions for this genotype are presented in table 8 and figure 15.

(i) Height of plant

This parameter registered continuous increase from 70 to 100 DAS and recorded a maximum value (43.45 cm) at the fourth harvest. This was however on par with the value recorded at 90 DAS (43.43 cm).

(ii) Number of mature pods

The value of this parameter increased from 70 to 80 DAS and attained a peak (19.77). After 90 DAS it showed a decline in value.

(iii) Percentage of mature pods

The parameter showed a gradual increase in value from 70 DAS to 90 DAS and recorded a maximum value (63.02) at 90 DAS. Further delay in the time of harvest decreased the value of this parameter quite significantly.

(iv) Pod yield

This parameter followed a more or less similar pattern of variation as the number of mature pods from

KEY

NUMBER OF MATURE PODS

POD YIELD

PERCENTAGE OF MATURE PODS

100 POD WEIGHT

100 KERNEL WEIGHT

SOUND MATURE KERNEL PERCENTAGE

SHELLING PERCENTAGE

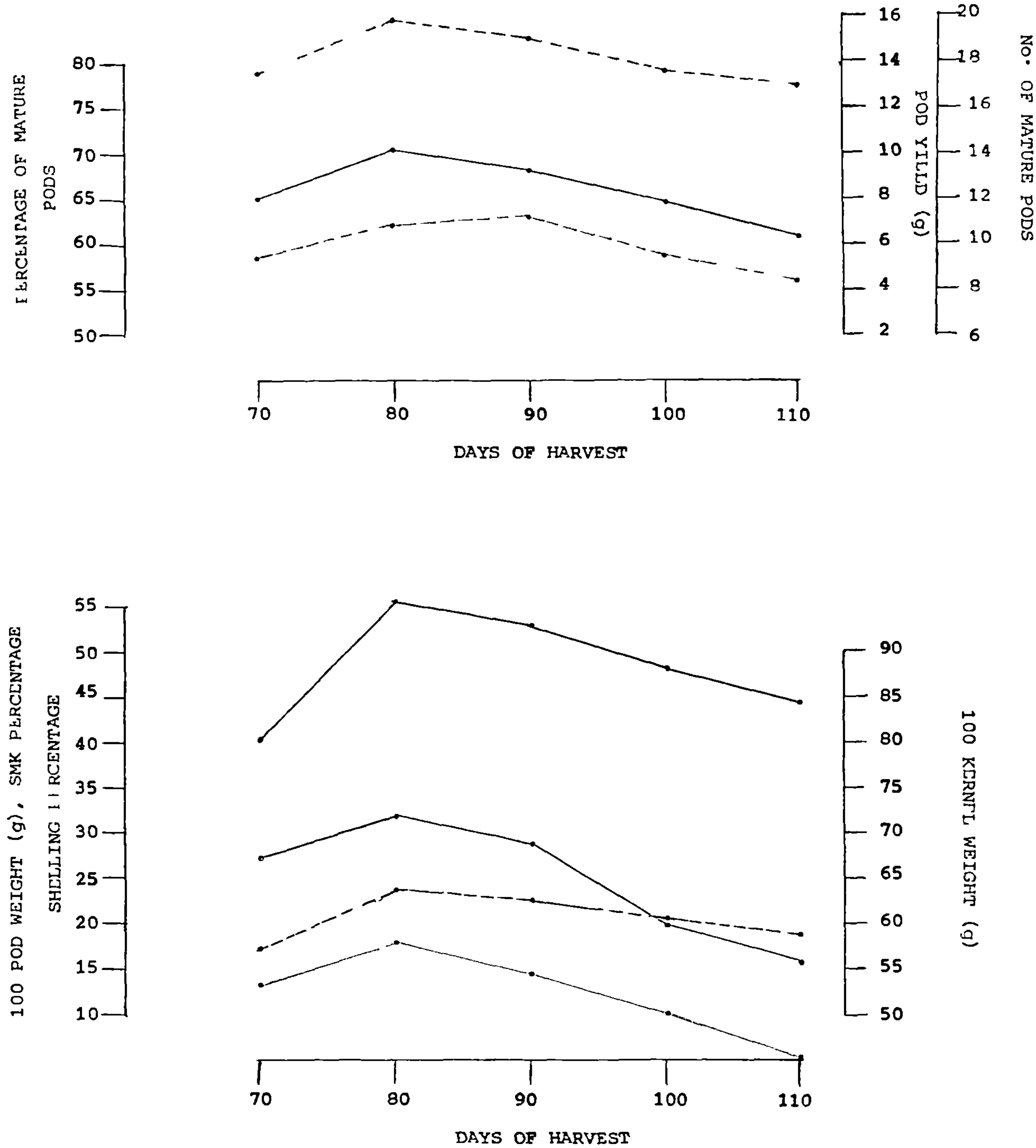

Fig. 15. Effect of staggered harvests on yield and component characters of the genotype Chico.

70 to 100 DAS, but declined at a comparatively faster rate thereafter. The peak value (10.10 g) was attained at 80 DAS.

(v) 100 pod weight

It registered an initial spurt in value during the first harvest interval to attain a peak value (55.48 g) at 80 DAS. Further delay in the time of harvest however caused progressive decline in the value of this parameter upto 110 DAS.

(vi) 100 kernel weight

This parameter also followed a more or less similar pattern of variation as 100 pod weight, with regard to the time of harvest. Maximum value of 100 kernel weight for the genotype was recorded at 80 DAS (23.86 g).

(vii) Shelling percentage

This parameter also followed a more or less similar trend as that of 100 pod weight and 100 kernel weight with regard to days of harvest. It recorded a peak value (57.90) at 80 DAS and steadily decline thereafter.

(viii) Sound mature kernel percentage

It showed an initial increase during the first harvest interval, recorded a peak value (71.93) at

80 DAS and then declined progressively with each successive harvest interval upto 110 DAS.

(ix) Haulms yield

The genotype registered the maximum value for this parameter at 70 DAS, after which it showed progressive decline until the final harvest. The maximum haulms yield for the genotype was recorded at 70 DAS (60.30 g). It was noted that the value of this parameter registered at 80 and 90 DAS were statistically on par.

(x) Harvest index

The value of this parameter increased between 70 and 80 DAS, kept steady till 90 DAS and further increased to record a maximum (0.21) at 100 DAS. It however declined during the final harvest interval.

(xi) Oil percentage

The genotype recorded a progressive increase in the oil percentage from 70 to 90 DAS, after which it showed progressive decline in value. The peak value for this parameter was recorded at 90 DAS (46.65).

DISCUSSION

5. DISCUSSION

The present study aims at analysing the maturity related components of bunch type groundnut in staggered harvests determining the time of optimum maturity and identifying the early maturing genotypes. The results of the experiment are discussed below.

5.1 Analysis of component characters

The analysis of the pooled data presented in tables 2 and 3 indicates that height of plant varied significantly with the time of harvest and the various genotypes. Its value increased continuously from 70 to 100 DAS and thereafter remained almost steady. Among the genotypes, TMV 2, TG 14 and IES 881 recorded the maximum plant height. Chico, however, proved to be the shortest.

Growth is defined as the progressive development of an organism and height is one of the important parameters for expressing it (Tisdale et al., 1985). Growth and development of plant infact, has led to the increase in plant height upto 100 DAS. The steady nature of plant height beyond 100 DAS may be attributed to the cessation of growth, characteristic of senescence or ageing. In groundnut, growth is basically a genotypic character, though largely influenced by seasonal and environmental factors; hence the variation among genotypes with regard to this parameter (Seshadri,1962; Sashidhar et al., 1977).

The number of primary and secondary branches were also significantly influenced by the time of harvest and the genotypes. The number of primary branches increased significantly with respect to delay in the time of harvest upto 80 DAS and the number of secondary branches upto 90 DAS, whereafter there occurred no significant change to either of the two parameters. From among the genotypes, TG 14, the yield check, and TG 3 gave the highest number of primaries and secondaries. IES 882, TMV 2 and Chico (duration check) also gave higher values for the number of secondaries. The genotypes IES 881 and Dh(E) 20 gave the lowest number of primaries and secondaries respectively.

Similar to plant height, the number of branches (both primary and secondary) also forms a major parameter indicative of growth and development of the plant, and hence increased in value with respect to the time of harvest. The plant must have attained maximum development with regard to this character by 90 DAS and hence did not show any further significant change during the later harvests. Being a growth parameter, this character too is under genotypic influence and hence varied among genotypes (Seshadri, 1962 and Sashidar et al., 1977).

The pooled data on the variations of yield and component characters of genotypes with time of harvest are presented in tables 2 and 3 and illustrated in figure 16.

The number of mature pods per plant also varied significantly with the time of harvest and the different genotypes. It registered significant increase in value with regard to the time of harvest only upto 90 DAS. Chico, the duration check, ranked first with regard to this parameter, followed by IES 882, ICGS(E)21 and IES 883. BPG 521 recorded the lowest value for this parameter.

Translocation of photosynthates from the leaves and other carbon-assimilating organs to the metabolically active sites forms a major process that influences growth and development in groundnut (Reddy, 1988a) During the early growth stages, partitioning of photosynthates and its translocation occurs mainly into the young expanding leaves, roots and stem, which function as active vegetative sinks. However, soon after the formation of pegs and initiation of pod development, the developing pods become the major sinks. At this

KEY

- NUMBER OF MATURE PODS
- POD YIELD
- PERCENTAGE OF MATURE PODS

- 100 POD WEIGHT
- 100 KERNEL WEIGHT
- SOUND MATURE KERNEL PERCENTAGE
- SHELLING PERCENTAGE

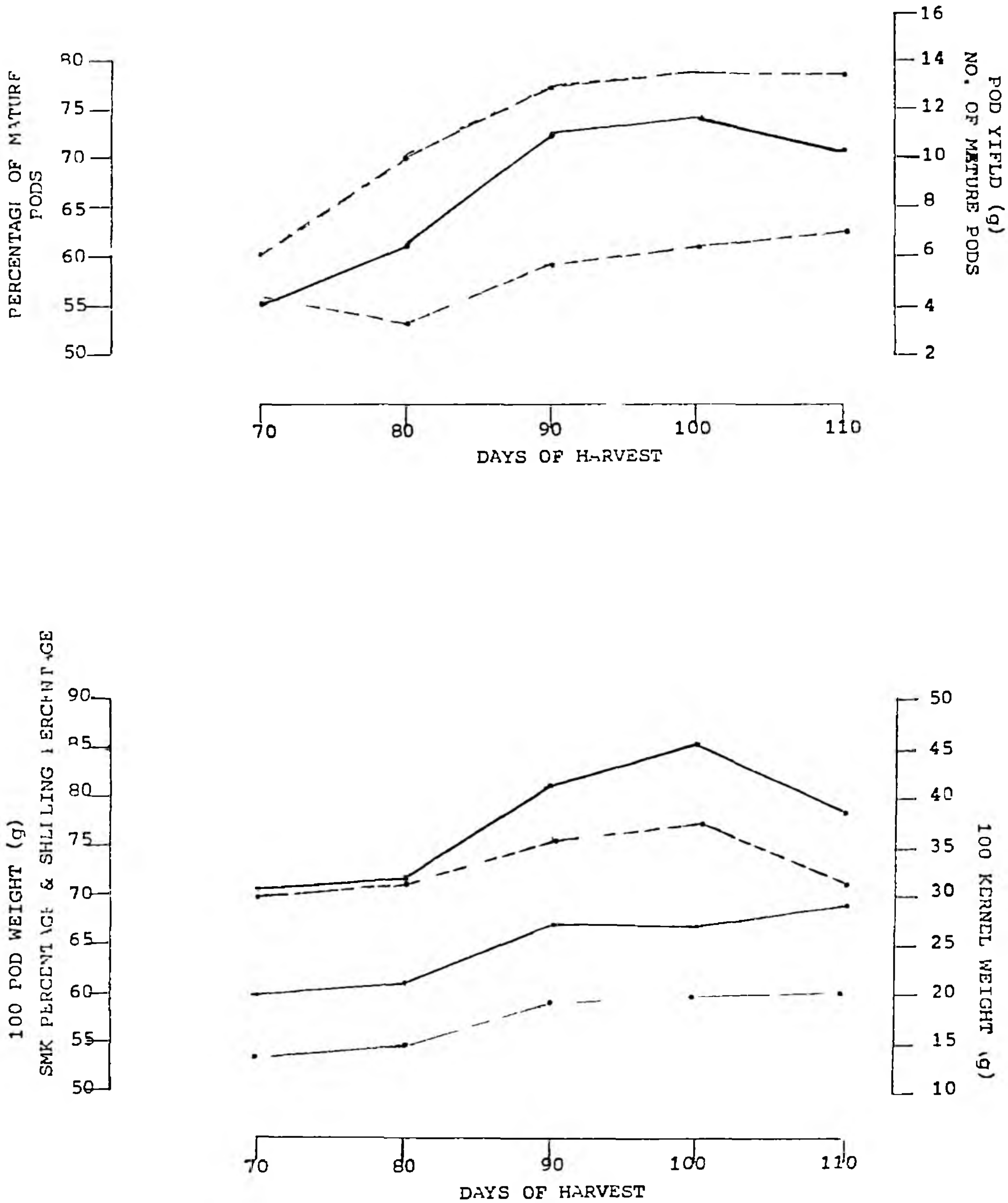

Fig. 16. Variation of yield and component characters with time of harvest.

stage, translocation from the foliage of each branch gets restricted mostly to the pods produced by that branch (Khan and Akosu, 1971). Bunting and Anderson (1960) reported that nearly 45 to 50 per cent of the total dry matter produced by the groundnut plant got accumulated in the kernels and 16 per cent in the shells, suggesting that nearly 65 per cent of the photosynthates gained entry into the developing pods after flowering and pod formation. The increased translocation of photosynthates into more and more developing pods has led to the increase in the number of mature pods with delay in the time of harvest. The absence of any notable increase in the number of mature pods after 90 DAS may be due to low leaf area and low photosynthetic efficiency of the plant during the final pod filling period characteristic of its nearness to maturity (Mc Cloud, 1974 and Hennings et al., 1979). The variation among genotypes with regard to this parameter may be attributed to their genetic differences.

The percentage of mature pods also was under the significant influence of the time of harvest and the genotypes. It recorded continuous increase in value with each successive harvest interval from 70 to 110 DAS. The genotype IES 885 registered the maximum value for the parameter, followed by TG 14, the yield check, The genotype TG 3, however recorded the lowest percentage of mature pods.

The percentage of mature pods as earlier mentioned refers to the number of mature pods expressed as percentage over the total number of pods produced by the plant. Thus the total number of pods set and the total number of mature pods are the two factors influencing this parameter. The significant increase in the percentage of mature pods with respect to days of harvest upto 90 DAS may be attributed to a corresponding increase in the number of mature pods during this time interval. However, unlike the number of mature pods, the percentage of mature pods increased significantly in the last two harvest also.

The proportion of developing pods attaining maturity depends on the time of pod initiation, total number of pods produced and the photosynthetic efficiency of the plant during the various stages of crop growth. Pods initiated earlier had a higher growth rate and they invariably attained maturity compared to those initiated later, when some reproductive sinks were already active (Williams, 1979 and Reddy, 1988).

Thus it is clear that the major share of photosynthates partitioned and translocated into the reproductive sink gains entry into the early formed pods which are metabolically more active. This makes the later formed immature pods less accessible to photosynthates and thereby adversely affect their survival. The presence of a large number of developing pods apparently arresting the maturation of a high proportion of them was reported by Cahaner and Ashri (1974). The internal stress created due to inadequate nutrient supply combined with environmental factors may have resulted in the deterioration of some of the immature pods during the later stages of crop growth. The elimination of immature pods naturally brings down the total number of pods and evidently increases the proportion of mature pods. This might have been the reason for the significant increase in the percentage of mature pods manifested during the last two harvests. The variation among genotypes with regard to this parameter may be attributed to their genetic differences.

Pod yield, the most important economic entity in groundnut also showed significant variation with respect to days of harvest and the genotypes. The parameter significantly increased in value from 70 to 100 DAS, attained a peak value and then declined significantly. The peak was attained through an initial appreciable increase from 70 to 90 DAS followed by a gradual increase till 100 DAS.

Pod yield in groundnut is a complex character that is under the direct influence of a number of components, termed yield components (Dorairaj, 1962). The number of mature pods showed very high positive direct effect on pod yield (Badwal and Singh, 1973; Sandhu and Khehra, 1977 ; Raju, 1978; Balkishan, 1979; Lakshmaiah et al., 1983 and Yadava et al., 1984). In addition, characters like 100 pod weight, 100 kernel weight and percentage of sound mature kernels also showed high positive direct effect on this character (Yadava et al., 1984 and Deshmukh et al., 1986). Pod yield was also indirectly influenced by shelling percentage. Hence an indepth study on the variation of these yield components will help a better understanding of the variation in pod yield as influenced by the time of harvest.

The 100 pod weight also showed significant variation with the different days of harvest and the various genotypes. It progressively increased from 70 to 100 DAS, attained a peak and declined thereafter. The peak was attained through an initial gradual increase from 70 to 80 DAS, followed by an appreciable increase upto 90 DAS and a further slow increase during the third harvest interval. Perusal of the data on table 3 shows that the time of harvest inflicted a more or less similar pattern of variation on 100 kernel weight also. It also recorded a maximum value at 100 DAS and declined thereafter.

The increase in the value of the above parameters with respect to time of harvest is a manifestation of growth and development, which is a function of time, genetic make up and environmental influence (Tisdale et al. 1985). It is well understood that nearly 50 per cent of the total dry matter produced by the plant accumulates in the kernels and only 16 per cent finds entry into the shells (Bunting and Anderson, 1960). This suggests that the kernels account for nearly 76 per cent of the total dry matter content of the pods and hence is undoubtedly the prime factor determining the pod weight. The apparantly similar pattern of variation exhibited by 100 pod weight and 100 kernel weight conforms with the above finding. Hence the variation of 100 pod weight with respect to time of harvest may be attributed to a similar variation exhibited by the character 100 kernel weight. The 100 pod weight attained peak value at 100 DAS since 100 kernel weight also showed peak performance at that point of time. Decline in the value of 100 kernel weight beyond 100 DAS resulted in a corresponding decline in the 100 pod weight also.

The 100 kernel weight gives an indication of the proper filling of the kernels (Reddy, 1988). The behaviour of the character 100 kernel weight at different days of harvest can be well explained in terms of general plant growth pattern, characterised by an initial gradual increase in value, followed by greater increases during active growth stage and then again a period of slow increase or no increase at all, which characterises growth cessation, suggesting crop maturity (Tisdale et al., 1985).

The rapid increase in the value of 100 kernel weight between 80 and 90 DAS may be attributed to the higher photosynthetic efficiency of the plant leading to an appreciable increase in the rate of translocation of metabolites and increased accumulation of photosynthates in the kernels (Khan and Akosu, 1971 and Duncan et al., 1978). At 100 DAS, the 100 kernel weight attained a plateau as in the normal growth pattern after which it did not show any further increase in value with respect to time. Kernels being the major sinks for translocated photosynthates (Bunting and Anderson, 1960), 100 kernel weight, an index of proper filling kernels (Reddy, 1988) is a major yield component that influence maturity in groundnut. Being a maturity related component, the attainment of a peak value by this parameter corresponds to the attainment of physiological maturity in groundnut (Rao and Gibbons, 1984).

Since pod setting and pod development in groundnut is a subterranean process, it is highly influenced by the soil environment throughout the crop growth period. Yadava and Kumar (1978) and Norden et al. (1986) reported high genotype x environment interaction for pod yield and components like 100 kernel weight, sound mature kernel yield and shelling percentage. The genotype x environment interaction might also have favoured an increase in the 100 kernel weight upto maturity, after which an unfavourable environmental influence might have favoured the decline in the value of this parameter. It has also been established that early maturing varieties fail to exhibit their inherent significant advantage in yield if they are not harvested early ie., at the time of optimum physiological maturity (Rao and Gibbons, 1984).

At the time of optimum physiological maturity, moisture content accounts for more than 40 per cent of the wet weight of groundnut pods which gets reduced to a level of 5-10 per cent on excessive drying (Dickens and Pattee, 1973). The significant reduction in the 100 kernel weight of groundnut genotypes after 100 DAS may be attributed to the rapid desiccation of pods under a high soil temperature. In addition, the crop left in the field after the attainment of physiological maturity incites the attack of fungus, especially Aspergillus flavus, leading to Aflatoxin production inside the kernels and thereby resulting in their deterioration (Reddy, 1988). This factor also might have contributed to the decline in 100 kernel weight manifested after maturity. A similar trend in behaviour of 100 kernel weight was also reported by Rao and Gibbons (1984).

The genotypes also varied significantly with regard to both 100 pod weight and 100 kernel weight. This may be attributed to their inherent genetic differences (Badwal and Gupta, 1968; Dixit et al., 1970; Khangura and Sandhu, 1972; Sangha and Sandhu, 1975; Sandhu and Khehra, 1976; Natarajan et al., 1978; Cahaner, 1978; Kumar and Yadava, 1979; Rao 1979a, Singh et al., 1982; Qadri and Khunti 1982 and Deshmukh et al., 1986). The genotypes TG 14 and JL 24, the two yield checks, proved to be the most superior with regard to these two parameters, while the duration check Chico turned out to be the most inferior.

Shelling percentage was also significantly influenced by the time of harvest and the different genotypes. It showed continuous increase in value from the first to the final harvest. Among the genotypes the yield check JL 24 gave the highest shelling percentage followed by ICGS(E) 52 and TG 14, the other yield check. IES 885 gave the lowest shelling percentage.

Shelling percentage denotes the percentage of kernels to pods by weight. It is dependant on the thickness of shell and development of kernels during the crop period (Reddy, 1988). The increase in the shelling percentage with regard to the time of harvest upto 100 DAS may be attributed to a corresponding increase in 100 kernel weight and 100 pod weight due to increase translocation and better accumulation of photosynthates in the kernels (Khan and Akosu, 1971 and Duncan et al., 1978). Further increase in the value of this parameter during the final harvest interval despite a decline in the value of 100 pod weight and 100 kernel weight may be attributed to a favourable kernel to pod ratio created due to deterioration of shells of pods after maturity (Reddy, 1988). The variation exhibited by the different genotypes for this character may be attributed to the differences in their genetic make up (Martin, 1967).

The percentage of sound mature kernels also varied significantly among the different days of harvest and the various genotypes. The value of this parameter increased from 70 to 100 DAS and declined thereafter. The genotype IES 881 recorded the maximum sound mature kernel percentage, followed by TG 3, Chico and IES 885.

Percentage of sound mature kernels and uniformity in size and shape of kernels are important attributes that determine the value and marketability of the produce. This along with 100 kernel weight may be regarded an index of the proper filling up kernels (Reddy, 1988). The variation in the percentage of sound mature kernels with respect to time of harvest may be attributed to an apparently similar variation expressed by the character 100 kernel weight as discussed earlier. The variation among genotypes with regard to this paramet may be attributed to their genetic differences.

From the above discussion, it can be concluded that the increase in pod yield with regard to time of harvest upto 100 DAS might have been contributed by a corresponding increase in the number of mature pods, 100 pod weight, 100 kernel weight, sound mature kernel percentage, all of which had high direct positive effects on this character (Badwal and Singh 1973; Sandhu and Khehra, 1977 ; Raju 1978; Balkishan, 1979; Lakshmaiah et al. 1983; Yadava et al. 1984 and Deshmukh et al., 1986). At 100 DAS, the pod yield recorded peak value corresponding to the peaks attained by these maturity related components thereby indicating attainment of optimum physiological maturity (Rao and Gibbons, 1984). The decline in pod yield exhibited after attainment of optimum maturity may be attributed to a corresponding decline in the value of these components.

Pod yield is a genotypic character, although highly influenced by the environment (Raman and Rangaswamy, 1970; Dixit et al., 1970; Patra, 1975; Lakshmaiah, 1978; Natarajan et al. 1978 ; Basu et al., 1986.). Hence the variation among genotypes with regard to this parameter may be attributed to their genetic differences. The yield check TG 14 recorded the highest pod yield followed by ICGS(E) 52, ICGS(E) 121, TMV 2 and JL 24(the other yield check). BPG 521 recorded the lowest pod yield.

Haulms yield also showed significant variation with regard to the days of harvest and the genotypes. It exhibited a sudden increase between 70 and 80 DAS, followed by a marginal increase to record a peak at 90 DAS. Further delay in the time of harvest resulted in considerable decline of the parameter. TG 14, the local yield check gave the highest haulms yield, followed by TG 3 and TMV 2. Chico gave the lowest yield of haulms.

The production of leaves and increase in shoot weight are considered as a measure of vegetative growth (Ali et al., 1932) and this occurred at a rapid rate during the early stages of crop growth due to increased photosynthetic efficiency. It however showed a declining trend towards the maturity of the crop (Rao, 1936). Thus the slower rate of increase in haulms yield nearing 90 DAS and its decline thereafter suggest that the crop was nearing maturity. A quicker cessation of vegetative growth facilities more photosynthates being available for accumulation in pods (Enyi, 1977). Thus the period of decline in haulms yield after attainment of a plateau may be considered as a period which facilities enhanced accumulationof photosynthates into the pods. Hence the significant increase in pod yield and yield attributes observed during this period. Significant direct effect of haulms yield on pod yield was also reported by Ibrahim (1983). In groundnut, vegetative growth is a genotypic character though largely influenced by seasonal and environmental conditions (Seshadri, 1962; Sashidar et al. 1977); hence the difference among genotypes with regard to this character.

The harvest index indicative of the proportion of economic produce to the total biomass, also showed significant variation with regard to the time of harvest and the genotypes. It increased with delay in the time of harvest upto 100 DAS and declined thereafter. The increase in harvest index might have resulted from an increased photosynthetic efficiency of the crop leading to increased translocation of metabolites into the active reproductive sink, viz., the developing pods (Khan and Akosu, 1971 and Enyi, 1977) Decline in harvest index after 100 DAS may be attributed to the decline in pod yield and yield components during this period due to reasons discussed earlier. The variation of harvest index among genotypes may be attributed to their genetic differences. The genotypes IES 883 and ICGS(E) 121 prov-ed to be most superior for the parameter. JL 24, the yield check recorded the lowest rate.

The oil percentage of kernels was also under the significant influence of the time of harvest and the genotypes. The oil percentage progressively increased from 70 to 110 DAS and recorded the maximum value at the final harvest. The increase in oil percentage may be attributed to the positive effect of growth on this parameter. Smartt (1976) opined that maximum oil content can be obtained if the crop was harvested at proper maturity. He added that oil accumulation was temperature sensitive and high temperature favoured high oil content. The increase in oil percentage observed after attainment of physiological maturity by the plant may be attributed to a favourable temperature relationship that might have occurred during the corresponding period.

The oil content being a varietal character (John, 1949), the genetic differences among the genotypes explain their varied performance with regard to this parameter. The genotype IES 881 registered the highest oil percentage, followed by Chico, the duration check. Dh(E) 32 gave the lowest value for the parameter.

5.2 Determination of time of optimum maturity of genotypes

The determination of time of optimum maturity of genotypes forms the second objective of the present study. Optimum physiological maturity in groundnut may be defined as that point of time in its life cycle, when certain maturity related components attain their peak values (Rao and Gibbons, 1984). Pod yield is the most important economic entity in groundnut and is dependant on a number of components like number of mature pods, 100 pod weight, 100 kernel weight and sound mature kernel percentage, all of which have high positive direct influence on this parameter (Badwal and Singh, 1973; Sandhu and Khehra, 1977; Raju, 1978; Balkishan, 1979; Lakshmaiah et al., 1983; Yadava et al., 1984 and Deshmukh et al., 1986). Thus the attainment of peak with regard to pod yield and its components may be considered as an index of physiological maturity in groundnut. The various characters studied in staggered harvests are analysed and discussed below with regard to each genotype.

IES 881

The variation of component characters of this genotype is illustrated in figure 1.

The genotype attained the maximum plant height at 90 DAS after which no further notable change occurred to this parameter. It recorded the maximum number of mature pods at 110 DAS. However an on par value was also recorded for the parameter at 100 DAS. Between 70 and 100 DAS the value of this parameter increased progressively with regard to time. The genotype recorded the highest percentage of mature pods also at 110 DAS. This was however attained through an initial non-significant decline followed by a steep increase and then a period of gradual increase for the parameter between the first and the final harvests. The most important economic character viz. pod yield attained its peak value at 100 DAS. It showed progressive increase from 70 to 100 DAS after which it showed significant decline in value. The increase in value of the parameter occurred at a faster rate between 80 and 90 DAS. The 100 pod weight also recorded peak performance at 100 DAS. It showed an initial declining trend and then followed a similar pattern of variation as pod yield upto the final harvest. The 100 kernel weight also exhibited a more or less similar pattern of variation as 100 pod weight and recorded peak value at 100 DAS. The genotype recorded the maximum shelling percentage at 110 DAS. However an on par value was also recorded at 90 DAS. The character also showed an initial declining trend followed by a steep increase upto 90 DAS. Further change in value of the parameter was non-significant. The sound mature kernel percentage also recorded its maximum value at the final harvest. It showed a more or less similar pattern of variation as the percentage of mature pods. The haulms yield recorded peak value at 90 DAS. The value of the parameter progressively increased from 70 to 90 DAS and declined thereafter. The genotype recorded the maximum harvest index at

100 DAS, which remained steady till the final harvest. It recorded maximum oil percentage at the final harvest. However a fairly high value for the parameter was also recorded at 100 DAS.

The behaviour of plant height with regard to time of harvest may be attributed to vegetative growth of plant upto 90 DAS and growth cessation thereafter (Tisdale et al., 1985). The increase in rate of translocation and the accumulation of photosynthetes into more or more developing pods resulted in the increase in number of mature pods upto the final harvest.(Bunting and Anderson, 1960 and Khan and Akosu, 1971). The initial decline in the percentage of mature pods may be attributed to an increase in the proportion of immature pods created due to setting of new pods (Williams et al.,1976 and Bunting and Elsten, 1980). The further significant increase in value of this parameter upto the final harvest may be attributed to a corresponding increase in the number of mature pods.

The initial decline in the 100 pod weight, 100 kernel weight, sound mature kernel percentage and shelling percentage of the genotype may be attributed to a corresponding decline manifested in the percentage of mature pods due to setting of new pods. The increase in 100 pod weight, 100 kernel weight and sound mature kernel percentage from 80 to 100 DAS may be considered as the manifestation of increased accumulation of metabolites into the kernels due to increased photosynthetic efficiency and effective translocation (Khan and Akosu, 1971 and Duncan et al., 1978). The shells of pods form the sinks for 16 per cent of the translocated photosynthates (Bunting and Anderson,1960). Hence the decline in the shelling percentage during the first and third harvest intervals may be explained as due to an unfavourable kernel to pod ratio created from a probable increase in the comparative shell weight due to increased accumulation of photosynthates. The appreciable increase in the haulms yield from 70 to 90 DAS may be attributed to the vigorous growth of plant during early vegetative phase owing to increased photosynthetic efficiency (Rao, 1936 and Forestier,1973). The termination of vegetative growth at 90 DAS might have facilitated more photosynthates being available for accumulation in the pods thereby leading to realisation of peak pod yield at 100 DAS (Enyi, 1977). This drain of photosynthates must have resulted in the decline in haulms yield after 90 DAS. The decline in 100 pod weight, 100 kernel weight and sound mature kernel percentage after 100 DAS may be attributed to rapid desiccation of pods under high soil temperature (Dickens and Pattee, 1973) and to deterioration of pods aided by attack of fungus (Reddy, 1988). The increase in harvest index with regard to time of harvest may be attributed to a favourable ratio of economic produce to total biomass facilitated by increase in pod yield and its components. The increasing trend of oil percentage with regard to time of harvest may be attributed to a positive effect of growth on this parameter and the favourable temperature relationship that existed during the crop growth period (Smartt, 1976).

The increase in pod yield between 70 and 80 DAS may be attributed to the increase in the number of mature pods and immature pods created during the corresponding period. Further increase in this parameter until 100 DAS may be attributed to a corresponding increase in the number of mature pods, percentage of mature pods, 100 pod weight, 100 kernel weight and sound mature kernel percentage. The decline in the pod yield observed after 100 DAS may be attributed to a corresponding decline in value exhibited by the above maturity related components (Rao and Gibbons, 1984).

The genotype can be considered to have attained optimum physiological maturity at 100 DAS due to manifestation of maximum pod yield associated with peak performance of maturity related components like number of mature pods, 100 pod weight, 100 kernel weight and sound mature kernel percentage.

IES 882

The variation of pod yield and component characters of this genotype in staggered harvests is illustrated in figure 2.

A perusal of the data in table 4 shows that the genotype registered maximum plant height at 100 DAS. However this was on par with the value recorded at 90 DAS. It recorded the maximum number of mature pods also at 100 DAS. This was achieved through a remarkable increase in the value of this parameter between 70 and 90 DAS and a further marginal and non-significant increase upto 100 DAS. The percentage of mature pods, recorded the highest value at the final harvest. The genotype recorded an initial slow increase in the value of this parameter followed by a steep increase upto 90 DAS. Between 90 and 110 DAS it showed only a non-significant increase to record the peak value at the final harvest. The pod yield attained peak value at 90 DAS beyond which it declined significantly. The peak value was attained through a steep, more or less linear increase during the first two harvest intervals. Similar to pod yield, the 100 pod weight and 100 kernel weight also attained peak performance at 90 DAS and declined thereafter. It can be noted that the increase in the value of these two parameters started at a comparatively faster rate and then continued at a slowed rate to record the peak value at 90 DAS. The shelling percentage also registered its peak value at 90 DAS. It however recorded a zigzag pattern of variation with respect to time of harvest manifested by a decline in value between 70 and 80 DAS, followed by an increase upto 90 DAS, a further decline till 100 DAS and a further increase upto 110 DAS. The genotype also recorded the maximum sound mature kernel percentage at 90 DAS which declined thereafter. It increased at a comparatively faster rate between 80 and 90 DAS than between 70 and 80 DAS. Haulms yield attained its peak value at 80 DAS declined in value in the subsequent harvests. The harvest index also attained maximum value at 90 DAS. It significantly increased from 70 to 90 DAS, kept steady till 100 DAS and finally declined. The oil percentage showed a progressive increase in value from the first to the final harvest.

The behaviour of plant height with regard to time of harvest may be attributed to vegetative growth of plant upto 90 DAS and growth cessation thereafter (Tisdale et al., 1985). The increase in photosynthetic efficiency, followed by increased translocation and accumulation of metabolites into more and more developing pods might have resulted in significant increase in the number of mature pods, 100 pod weight, 100 kernel weight and sound mature kernel percentage upto 100 DAS. (Bunting and Anderson, 1960 and Khan and Akosu, 1971). The initial slow increase in the percentage of mature pods, despite a marked increase in the number of mature pods may be attributed to an increase in the proportion of immature pods created due to setting of new pods (Williams et al., 1976 and Bunting and Elsten, 1980). Further increase in the percentage of mature pods may be attributed to a corresponding increase in the number of mature pods.

The progressive increase in pod yield upto 90 DAS may be attributed to the increase in the yield components viz., number of mature pods, percentage of mature pods, 100 pod weight, 100 kernel weight and sound mature kernel percentage. The decline in pod yield after 90 DAS may be attributed to a corresponding decline in the value of 100 pod weight, 100 kernel weight and sound mature kernel percentage. The decline in 100 pod weight, 100 kernel weight and sound mature kernel percentage after 90 DAS may be attributed to rapid desiccation of pods under high soil temperature (Dickens and Pattee, 1973) and to deterioration of pods aided by the attack of fungus (Reddy, 1988).

The genotype may be considered to have attained optimum physiological maturity at 90 DAS due to attainment of peak pod yield, 100 pod weight, 100 kernel weight sound mature kernel percentage and shelling percentage and significantly superior values for number of mature pods and percentage of mature pods. At the time of optimum maturity the genotype also recorded the maximum harvest index and also a fairly high oil percentage.

IES 883

The variation of pod yield and component characters of this genotype with time of harvest is illustrated in figure 3.

Perusal of the data given in table 4 shows that the genotype recorded the maximum plant height at 100 DAS, although an on par value was also obtained at 90 DAS. It registered the highest number of mature pods also at 90 DAS. The parameter showed progressive increase in value from 70 to 90 DAS and then kept almost steady. The maximum percentage of mature pods was obtained at 110 DAS. It however gave an on par value at 100 DAS also. The parameter registered an initial steep decline followed by a corresponding increase between 70 and 90 DAS. Beyond 90 DAS it recorded only a marginal increase. The genotype exhibited maximum pod yield at 90 DAS. The parameter showed progressive increase with regard to time of harvest from 70 to 90 DAS, whereafter it declined. The 100 pod weight also recorded an initial, though slight, decline in value between 70 and 80 DAS. This was however followed by a spurt in value upto 90 DAS and significant decline thereafter. The 100 kernel weight also showed an almost similar trend of variation as 100 pod weight, also attaining the peak value at 90 DAS. The genotype recorded maximum shelling percentage at 110 DAS. However fairly high values for the parameter were also attained at 90 and 100 DAS, which were on par with each other. The character recorded an initial decline in value followed by an increase between 70 and 90 DAS. It remained almost steady till 100 DAS and again increased to record a maximum at the final harvest. Sound mature kernel percentage also showed the peak performance at 90 DAS. Similar to percentage of mature pods, 100 pod weight, 100 kernel weight and shelling percentage, it also showed an initial decline in value followed by an abrupt increase to record the peak value at 90 DAS, after which it declined. Haulms yield recorded the peak value at 80 DAS and declined in the later harvests. The genotype recorded the maximum harvest index at 90 DAS and 110 DAS. It showed a decline between 70 and 80 DAS followed by a sharp increase upto 90 DAS a further decline upto 100 DAS and again a rise till the final harvest. Oil percentage attained the peak value at the final harvest. It however recorded fairly high value at 90 DAS also.

The behaviour of the characters viz., plant height and number of mature pods with time of harvest may be attributed to similar reasons discussed earlier. The initial decline in the percentage of mature pods despite an increase in the number of mature pods between 70 and 80 DAS may be due to a corresponding decline in the proportion of mature pods created due to setting of new pods by the plant (Williams et al., 1976 and Bunting and Elsten, 1980). This indeed might have contributed to the decline manifested in the 100 pod weight, 100 kernel weight, sound mature kernel percentage and shelling percentage during the corresponding period. The appreciable increase realised by the above parameters between 80 and 90 DAS may be attributed to higher photosynthetic efficiency of the plant, effective translocation and added accumulation of photosynthates into the pods (Bunting and Anderson,1960 and Khan and Akosu, 1971).

The initial increase exhibited by pod yield may exclusively be attributed to the significant increase in number of mature pods between 70 and 80 DAS. Further increase in the parameter upto 90 DAS and its decline thereafter may be attributed to a similar pattern of variation exhibited by 100 pod weight, 100 kernel weight, sound mature kernel percentage and shelling percentage, apart from the number of mature pods. The decline in the values of 100 pod weight, 100 kernel weight, sound mature kernel percentage after 90 DAS may be attributed to drastic reduction in the moisture content of kernels, created due to rapid desiccation of pods under high soil temperature (Dickens and Pattee, 1973) and to the deterioration of pods accelerated by the attack of fungus (Reddy, 1988). The increase in shelling percentage during the final harvest interval, despite reduction in the values of all other yield components may be explained in terms of deterioration of shells of pods, thereby creating a favourable kernel to pod ratio by weight.

This genotype also may be considered to have attained optimum physiological maturity at 90 DAS due to peak values attained by the economic entities viz., pod yield, 100 pod weight, 100 kernel weight, sound mature kernel percentage and significantly high values recorded by number of mature pods and percentage of mature pods. At optimum maturity, however, the genotype also recorded the peak harvest index and fairly high oil and shelling percentages.

IES 885

The variation of pod yield and component characters of the genotype IES 885 is illustrated in figure 4.

The perusal of data in table 5 indicates that the genotype recorded maximum plant height at 100 DAS. However it showed an on par value for this parameter at 90 DAS. The maximum number of mature pods was also attained at 100 DAS. It however registered on par value at 90 DAS also. The parameter showed appreciable increase in value with time of harvest upto 90 DAS and recorded only a non-significant change thereafter. The maximum percentage of mature pods was recorded at 110 DAS. This was attained through an initial decline during the first harvest interval followed by progressive increase in value in the later harvests. The pod yield showed progressive increase in value from the first to the third harvest recorded a peak value at 90 DAS and then declined. Similar to the percentage of mature pods, the 100 pod weight and 100 kernel weight also recorded an initial declining trend followed by a significant increase between 80 and 90 DAS. Both these parameters registered peak value at 90 DAS as in the case of pod yield, after which they declined with time of harvest. The genotype also recorded peak shelling percentage at 90 DAS. Till 100 DAS, the shelling percentage also followed an almost similar pattern of variation as 100 pod weight and 100 kernel weight. However it showed further increase in value after 100 DAS. The sound mature kernel percentage also attained a peak value at 90 DAS. This also followed a similar pattern of variation as 100 pod weight and 100 kernel weight from the first to the final harvest. Haulms yield for the genotype registered the peak at 80 DAS and declined thereafter. Peak harvest index was recorded at 100 and 110 DAS. The maximum oil percentage was attained at the final harvest. However a fairly high value for this parameter was also obtained at 90 DAS.

The behaviour of characters viz., plant height, number of mature pods, percentage of mature pods, 100 pod weight, 100 kernel weight and shelling percentage followed a roughly similar pattern as those of the genotype IES 883 and hence may be attributed to the same reasons discussed under it.

The increase in pod yield between 70 and 80 DAS may exclusively be attributed to a corresponding increase in the number of mature pods. The further rise in this parameter upto 90 DAS might have occurred due to the significant increase in the 100 pod weight, 100 kernel weight, sound mature kernel percentage and shelling percentage, apart from the number of mature pods. Similarly the decline in above characters after 90 DAS might have resulted in significant decline in pod yield. The final increase in shelling percentage after 100 DAS may have been due to a decline in the weight of shells that might have been inflicted due to pod deterioration (Reddy, 1988). The increase in harvest index after 90 DAS may be attributed to a favourable ratio of pod yield to total biomass created by senescence.

From the above discussion, it can be understood that the genotype attained optimum physiological maturity at 90 DAS, when it recorded the maximum pod yield, optimum value of number of mature pods and peak values for 100 pod weight, 100 kernel weight, sound mature kernel percentage and shelling percentage. It was however noted that fairly high oil content was also realised at the time of optimum maturity.

ICGS(E) 21

The behaviour of pod yield and yield attributes of the genotype ICGS(E) 21 with regard to time of harvest is illustrated in the figure 5.

Analysis of data in table 5 indicates that maximum height of plant for the genotype was recorded at 100 DAS. However, the parameter showed significant increase in value only upto 90 DAS. The number of mature pods too significantly increased only upto 90 DAS, although it recorded maximum value at 100 DAS. As in the earlier cases the percentage of mature pods attained maximum at the final harvest. The pod yield exhibited peak performance at 90 DAS and declined thereafter. An almost linear increase was manifested by the parameter between 70 and 90 DAS. The 100 pod-weight and 100 kernel weight also attained peak values and 90 DAS. Both these parameters followed an almost similar trend of behaviour as the pod yield with regard to time of harvest. The genotype registered maximum shelling percentage at 110 DAS. Appreciable increase for the parameter was however obtained between 90 and 110 DAS. The sound mature kernel percentage also exhibited a roughly similar patternof variation as 100 pod weight and 100 kernel weight, recording peak value at 90 DAS. The haulms yield expressed a sudden increase during the first harvest interval to record a peak value at 80 DAS and declined during the subsequent harvest intervals. The genotype recorded peak harvest index also at 90 DAS and the value kept steady in the remaining two harvests also. The final harvest also witnessed maximum oil percentage for the genotype. However a fairly high value for this parameter was also registered at 90 DAS.

The behaviour of characters like plant height and number of mature pods with time of harvest may be explained in terms of growth and development of plant upto 90 DAS and growth cessation thereafter (Tisdale et al., 1985). The increase in the percentage of mature pods upto 90 DAS may be attributed to a corresponding increase in the number of mature pods. However, the further increase exhibited by this parameter upto the final harvest may be attributed to a favourable ratio of number of mature pods to total number of pods, created due to deterioration of immature pods (Cahaner and Ashri, 1974). The increase in 100 pod weight, 100 kernel weight and sound mature kernel percentage upto 90 DAS may be well explained in terms of enhanced photosynthetic efficiency, effective translocation and increased accumulation of metabolites into the developing pods (Bunting and Anderson, 1960 and Khan and Akosu, 1971); their decline after 90 DAS to rapid desiccation of pods under high soil temperature (Dickens and Pattee, 1973) and fungal deterioration (Reddy,1988).

The increase in pod yield from 70 to 90 DAS may be associated with a corresponding increase in the number and percentage of mature pods, 100 pod weight, 100 kernel weight, sound mature kernel percentage and harvest index. The decline in pod yield after 90 DAS may be attributed to a corresponding decline in the 100 pod weight, 100 kernel weight and percentage of sound mature kernels. The slight decline in shelling percentage between 80 and 90 DAS may be attributed to a possible increase in shell thickness that might have occurred during this period creating an unfavourable ratio of kernels to pods by weight; shells being reservoirs for 16 per cent of assimilated photosynthates (Bunting and Anderson, 1960). The appreciable increase in shelling percentage between 90 and 110 DAS may be attributed to a favourable ratio of kernels to pods created due to deterioration of shells of kernels, inflicted by the environment.

From the above discussion it can be understood that the genotype attained optimum physiological maturity at 90 DAS due to realisation of maximum pod yield, associated with optimum number of mature pods and peak values for 100 pod weight, 100 kernel weight and sound mature kernel percentage. It also gave a moderate high oil percentage at maturity.

ICGS(E) 52

The variation of yield and component characters of the genotype ICGS(E) 52 is illustrated in the figure 6.

A perusal of the data in table 5 reveals that plant attain maximum height at 100 DAS. Nevertheless it showed significant increase only upto 90 DAS. The number of mature pods also expressed significant increase in value only upto 90 DAS, even though it registered peak value at 100 DAS. The percentage of mature pods however increase with delay in the time of harvest upto 110 DAS. The genotype registered peak pod yield at 90 DAS. This was attained through a steep and almost steady increase in the value of this parameter between 70 and 90 DAS. Further delay in time of harvest witnessed significant decline in pod yield. The 100 pod weight and 100 kernel weight also registered peak values at 90 DAS. They followed a roughly similar pattern of variation with an initial slow increase followed by a spurt in value upto 90 DAS and a decline in value in the subsequent harvests. The shelling percentage recorded peak value at 110 DAS, eventhough an on par value was also recorded at 90 DAS. In its course the shelling percentage registered an initial decline in value followed by a significant increase upto 90 DAS. The maximum sound mature kernel percentage for the genotype was also recorded at 90 DAS. It registered a more or less similar pattern of variation as pod yield, 100 pod weight and 100 kernel weight from the 80 to 110 DAS. The peak haulms yield for the genotype was recorded at 80 DAS and it declined in the later harvests. The genotype recorded peak harvest index and a fairly high oil percentage also at 90 DAS.

The behaviour of character like plant height, number of mature pods, percentage of mature pods, 100 pod weight, 100 kernel weight and sound mature kernel percentage for this genotype may be attributed to the same reasons dealt with under the genotype ICGS(E) 21. The decline in shelling percentage during the first harvest interval may be attributed to a corresponding increase in shell thickness due to effective translocation of metabolites into the shells of pods (Bunting and Anderson, 1960).

The increase in pod yield between 70 and 90 DAS may be attributed a corresponding increase in the number and percentage of mature pods, 100 pod weight, 100 kernel weight, sound mature kernel percentage and harvest index and its decline after 90 DAS, to a corresponding decline in 100 pod weight, 100 kernel weight and sound mature kernel percentage.

This genotype also may be said to have attained optimum physiological maturity at 90 DAS due to attainment of peak pod yield associated with optimum number of mature pods and peak values for 100 pod weight, 100 kernel weight, sound mature kernel percentage, shelling percentage and harvest index.

ICGS(E) 121

The variation of pod yield and component characters of this genotype is illustrated in figure 7.

A study of the data presented in table 6 shows that the genotype recorded maximum plant height at 90 DAS. The number of mature pods exhibited significant increase only upto 90 DAS. The percentage of mature pods recorded maximum value at the final harvest. In its course it registered a significant declining trend upto 80 DAS followed by progressive increases during the subsequent harvest intervals. Pod yield recorded peak value at 90 DAS. This was attained through an initial rapid increase in the value of the parameter followed by a comparatively slower increase, between 70 and 90 DAS. It however showed significant decline in value during the subsequent harvest. The 100 pod weight and 100 kernel weight also attained peak values at 90 DAS. They followed a more or less similar pattern of variation as pod yield with respect to days of harvest, from 80 DAS. The genotype also recorded peak shelling percentage at 90 DAS. It showed an initial decline in value followed by an increase to record a maximum at 90 DAS, after which it showed a gradual decline. The sound mature kernel percentage also attained peak performance at 90 DAS. It also showed an almost similar pattern of variation as pod yield from 70 to 110 DAS. The haulms yield registered a rapid increase during the first harvest interval to record a peak value at 80 DAS and declined thereafter. Harvest index also showed an increasing trend between 70 and 90 DAS to record a maximum at 90 DAS, kept steady till 100 DAS and then declined. The genotype registered peak oil percentage at the final harvest.

The behaviour of characters like plant height, number of mature pods and percentage of mature pods with respect to time of harvest may be attributed to similar reasons as detailed under IES 883. The initial decline in the 100 pod weight, 100 kernel weight and shelling percentage manifested for the genotype may be explained in terms of decline in the percentage of mature pods during the respective period. Further increase in the value of the above parameters and sound mature kernel percentage upto 90 DAS may be attributed to increased photosynthetic efficiency, effective translocation and increased accumulation of metabolites into the developing pods (Bunting and Anderson, 1960 and Khan and Akosu, 1971) and their decline thereafter to rapid desiccation of pods under high soil temperature (Dickens and Pattee, 1973) and deterioration of pods aided by fungal attack (Reddy, 1988).

The increase in pod yield upto 80 DAS may be attributed to the corresponding increase exhibited by the number of mature pods and sound mature kernel percentage. Further increase in pod yield, in addition to these two factors, was also contributed by increase in 100 pod weight, 100 kernel weight and harvest index. The decline in the value of this parameter after 90 DAS may however be attributed to a corresponding decline in the value of 100 pod weight, 100 kernel weight and sound mature kernel percentage.

The genotype may be said to have attained physiological maturity at 90 DAS due to registration of peak pod yield followed by optimum number of mature pods and peaks for 100 pod weight, 100 kernel weight, sound mature kernel percentage, shelling percentage and harvest index. At optimum maturity the genotype also rendered a fairly high oil percentage.

Dh(E) 20

The variation of yield and component characters of the genotype Dh(E) 20 is illustrated in figure 8.

A perusal of the table 6 shows that the genotype attained maximum plant height at 100 DAS, however recording an on par value at 90 DAS. The number of mature pods also registered significant increase only upto 90 DAS, eventhough it recorded the peak value at 110 DAS. This was attained through a initial slow increase followed by rapid increase from 70 to 90 DAS. The percentage of mature pods however registered an initial decline in value followed by progressive increases in value from 70 to 110 DAS, in its way to record peak value at the final harvest. The pod yield recorded peak performance at 90 DAS through an appreciable increase in value with respect to time during the first two harvest intervals. It however declined thereafter. The 100 pod weight and 100 kernel weight also attained peak values at the third harvest. These parameters also showed an almost similar pattern of behaviour as the pod yield from 80 to 110 DAS. However the initial decline in value of this parameter may be attributed to a similar decline in the percentage of mature pods. The genotype registered the peak shelling percentage at 90 DAS. It declined in value upto 80 DAS and then increased to record the peak value. This trend was repeated between 90 and 110 DAS. The trend of the parameter from 70 to 100 DAS was roughly similar to that of percentage of mature pods, 100 pod weight and 100 kernel weight. The percentage of sound mature kernels also followed a similar trend as pod yield, with the maximum value recorded at 90 DAS. Haulms yield attained peak value at 80 DAS and declined thereafter. Harvest index showed an increase during the second harvest interval to record a peak value at 90 DAS whereafter it remained steady for one more harvest interval and then declined. The genotype registered peak oil percentage at the final harvest. However a fairly high value for the parameter was also obtained at 90 DAS.

The behaviour of characters viz., plant height, number and percentage of mature pods, 100 pod weight, 100 kernel weight, sound mature kernel percentage and shelling percentage of this genotype can be noted to have followed an almost similar pattern of variation as of ICGS(E) 121 and hence may be explained in terms of the same reasons as detailed earlier.

The increase in the pod yield upto 80 DAS was effected by a significant increase in the mature pods and sound mature kernel percentage. Further increase in this parameter, was also contributed by significant increases registered by characters like 100 pod weight, 100 kernel weight, sound mature kernel percentage and harvest index during the second harvest interval. The decline in pod yield after 90 DAS may be attributed to 100 pod weight, 100 kernel weight, sound mature kernel percentage and shelling percentage, which also declined in value during the respective period.

This genotype also can be said to have attained optimum maturity at 90 DAS due to the attainment of peak pod yield, optimum number of mature pods and peak values for 100 pod weight, 100 kernel weight, sound mature kernel percentage, shelling percentage and harvest index. Oil percentage also exhibited fairly high value at this stage.

Dh(E) 32

The variation of pod yield and yield components of the genotype Dh(E) 32 is illustrated in the figure 9.

A perusal of the data in table 6 shows that the genotype attained maximum plant height at 100 DAS.

However this was statistically on par with the plant height at 90 DAS. The number of mature pods showed significant increase in value only upto 90 DAS, eventhough it recorded maximum value at 100 DAS. The percentage of mature pods attained maximum value at the final harvest. Meanwhile it registered a significant initial decline in value during the first harvest interval, but further increased in magnitude till the final harvest. Pod yield recorded peak value at 90 DAS. It registered a gradual increase in value followed by a rapid increase in magnitude from 70 to 90 DAS, to record the peak value at the third harvest. Beyond 90 DAS it registered a significant decline in value. The 100 pod weight and 100 kernel weight followed an almost similar pattern of variation with an initial decline in value and a further trend simulating pod yield upto the final harvest. They also registered peak values at 90 DAS. The genotype recorded the maximum shelling percentage at 110 DAS but this was on par with its performance at 90 DAS. It registered an initial decline in value followed by an increase between 70 and 90 DAS. This trend was again repeated between 90 and 110 DAS. Maximum percentage of sound mature kernels was reported at 90 DAS. This parameter also followed a similar pattern of variation as 100 pod weight and 100 kernel weight with regard to time of harvest. Haulms yield showed a sharp increase during the first harvest interval to record a peak value at 80 DAS, after which it declined. The genotype registered maximum harvest index at 100 DAS which declined thereafter. The final harvest witnessed the attainment of peak oil percentage.

The behaviour of characters viz., plant height, number and percentage of mature pods, 100 pod weight, 100 kernel weight, sound mature kernel percentage and shelling percentage of this genotype may be attributed to the same reasons as detailed under the genotype ICGS(E) 121.

The increase in pod yield upto 80 DAS may exclusively be attributed to the increase in the number of mature pods. The further increase in pod yield from 80 to 90 DAS may be explained in terms of the increase in the number of mature pods, 100 pod weight, 100 kernel weight, sound mature kernel percentage, shelling percentage and harvest index.

Ninety DAS may be adjudged the time of optimum maturity of this genotype due to realisation of maximum pod yield associated with optimum number of mature pods and peak values for 100 pod weight, 100 kernel weight, shelling percentage and sound mature kernel percentage. A fairly high oil percentage was also attained at this harvest.

BPG 521

The variation of pod yield and component characters of the genotype BPG 521 is illustrated in figure 10.

A perusal of the data in table 7 shows that the genotype attained maximum plant height at 100 DAS. The number of mature pods showed progressive increase with regard to time of harvest upto 110 DAS when it recorded the maximum value. It was however noted that an on par value was also recorded for the parameter at 100 DAS. The percentage of mature pods also followed a roughly similar trend of variation as the number of mature pods between 80 and 110 DAS to record the maximum value at the final harvest. Pod yield attained peak value at 100 DAS and declined thereafter. The peak was achieved through an initial slow increase in value during the first harvest interval followed by appreciable increases upto 100 DAS. The 100 pod weight and 100 kernel weight also attained peak values at 100 DAS and followed an almost similar variation as of pod yield with regard to time of harvest. Shelling percentage showed a more or less steady and gradual increase from 70 to 100 DAS, record a peak and declined thereafter. The fourth harvest also witnessed the attainment of peak sound mature kernel percentage. The genotype recorded maximum haulms yield at 90 DAS which declined thereafter. The peak harvest index was also recorded at 100 DAS. In its course the value of this parameter showed progressive increase from 70 to 100 DAS and then declined. The final harvest witnessed the maximum oil percentage for the genotype.

The behaviour of characters viz., plant height and number of mature pods of the genotype may be attributed to similar reasons as detailed under the genotype IES 881. The increase in the percentage of mature pods, 100 pod weight, 100 kernel weight, sound mature kernel percentage and shelling percentage with regard to time of harvest upto 100 DAS may be explained in terms of enhanced photosynthetic efficiency of the plant causing effective translocation and increased accumulation of photosynthates into the developing pods (Bunting and Anderson, 1960 and Khan and Akosu, 1971). The decline in the value of the above parameters after 100 DAS may be attributed mainly to moisture loss of kernels and deterioration of pods due to fungal attack (Dickens and Pattee, 1973 and Reddy, 1988).

The increase in the pod yield from 70 to 100 DAS may be attributed to a corresponding increase in the number of mature pods, percentage of mature pods, 100 pod weight, 100 kernel weight, sound mature kernel percentage, shelling percentage and harvest index. The decline in its value after 100 DAS may be attributed to the decline manifested in all the above parameters excepting the number and percentage of mature pods.

This genotype can be said to have optimum physiological maturity at 100 DAS due to the manifestation of maximum pod yield followed optimum number of mature pods and percentage of mature pods and peak values for 100 pod weight, 100 kernel weight, sound mature kernel percentage, shelling percentage and harvest index. A fairly high oil content was also obtained at this stage.

JL 24

The variation of pod yield and component characters of this genotype are presented in figure 11.

A perusal of the data in table 7 shows that the genotype attained peak plant height at 100 DAS. The number of mature pods significantly increased only upto 100 DAS eventhough the maximum value was recorded at

110 DAS. The percentage of mature pods exhibited gradual and more or less steady increase from the first to the final harvest. Pod yield registered the peak value at 100 DAS. This was arrived at through a more or less steady increase from 70 to 100 DAS. The final harvest however witnessed a reduction in the pod yield. The 100 pod weight and 100 kernel weight also registered their peaks at 100 DAS with a slow initial increase in value during the first harvest interval, followed by rapid spurt during the second and third harvest intervals. The final harvest registered significant reduction in the value of these two parameters. The genotype exhibited maximum shelling percentage at the final harvest. In its course the parameters registered appreciable increase during the first, third and fourth harvest intervals. No significant variation for the parameter was observed during the second harvest interval. The sound mature kernel percentage also registered its peak value at 100 DAS. It followed a roughly similar patterns of variation as of 100 pod weight and 100 kernel weight. Haulms yield showed steep and steady increase with time of harvest to record a peak at 90 DAS after which it declined. The genotype recorded the peak harvest index and maximum oil percentage at the final harvest. The harvest index

as 100 pod weight and 100 kernel weight upto 100 DAS. However unlike the above characters it continued to increase upto the final harvest. The sound mature kernel percentage also followed an almost similar pattern of behaviour as 100 pod weight and 100 kernel weight, recording its peak at 100 DAS. The peak haulms yield for the genotype was recorded at 90 DAS where-after it declined significantly. The final harvest witnessed peak performances for harvest index and oil percentage, both having progressively increased in value from the first to the final harvest.

The behaviour of characters viz., plant height, number and percentage of mature pods, 100 pod weight, 100 kernel weight and sound mature kernel percentage of the genotype may be attributed to similar reasons as detailed under IES 881. The initial decline in shelling percentage may be the result of a corresponding decline in 100 pod weight and 100 kernel weight, due to reduction in the percentage of mature pods (Bunting and Elsten, 1980). Further increase of the parameter upto 100 DAS may be attributed to a similar increase in the above said components. The increase in shelling percentage during the final harvest interval may be the result of a favourable kernal to pod ratio created due to deterioration of shells under environmental influence.

registered an initial rapid increase followed by a gradual increase upto 90 DAS and then a spurt in value upto 100 DAS.

The increase in characters viz., plant height and number of mature pods upto 100 DAS may be explained as manifestation of growth and development of the plant and their steadiness thereafter to growth cessation (Tisdale et al., 1985). The continuous increase in the percentage of mature pods from 70 to 100 DAS may be considered as the manifestation of a corresponding increase in the number of mature pods. The further increase in the value of this parameter is the result of a favourable ratio created due to deterioration of immature pods due to want of assimilated metabolites (Cahaner and Ashri, 1974). The behaviour of characters viz., 100 pod weight, 100 kernel weight and sound mature kernel percentage may be attributed to the same reasons detailed under the genotype BPG 521. The increase in shelling percentage during the first and third harvest intervals may be attributed to the corresponding increase in 100 pod weight and 100 kernel weight (Khan and Akosu, 1971). The further increase shown by the parameter after 100 DAS may be explained in terms of a favourable kernel to pod ratio by weight created through the deterioration of shells of pods under environmental influence. The apparent steadiness in shelling percentage during the second harvest interval may be on account of a probable comparative increase in shell thickness created due to better accumulation of photosynthates into it (Bunting and Anderson, 1960). The spurt in harvest index between 90 and 100 DAS corresponds to a similar spurt in 100 pod weight and 100 kernel weight manifested during that time interval.

The increase in the pod yield upto 100 DAS may be attributed to a corresponding increase in the number of mature pods, percentage of mature pods, 100 pod weight, 100 kernel weight, sound mature kernel percentage and shelling percentage. The decline in value of pod yield after 100 DAS may be attributed to a corresponding decline registered by characters viz., 100 pod weight, 100 kernel weight and sound mature kernel percentage due to reasons discussed earlier.

The genotype may be adjudged to have attained optimum physiological maturity at 100 DAS due to attainment of maximum pod yield with optimum number of mature and peak values for 100 pod weight, 100 kernel weight and sound mature kernel percentage.

TMV 2

The variation of pod yield and yield component of the genotype TMV 2 is illustrated in the figure 12.

A perusal of the data in table 7 shows that the genotype attained maximum plant height at 110 DAS. The number of mature pods attained its peak value at 100 DAS after which it did not show any significant change in value. The character increased in value initially at a faster rate which gradually slowed down with each successive harvest interval and finally attained a maximum value at the final harvest. The percentage of mature pods registered a steady increase in value from 80 to 110 DAS and recorded the peak value at the final harvest. The pod yield recorded continuous increase with respect to time of harvest attained a peak at 100 DAS and then declined. With each successive harvest interval the rate of increase of the parameter enhanced until the attainment of the peak value. The 100 pod weight and 100 kernel weight also registered an almost similar pattern of variation as pod yield until the final harvest. The shelling percentage attained peak value at 110 DAS. The parameter showed appreciable increase in magnitude from the third to the final harvest. The maximum sound mature kernel percentage for the genotype was recorded at 100 DAS. It showed a gradual and steady increase upto 100 DAS and declined thereafter. The haulms yield registered a rapid steady increase with regard to time of harvest upto 90 DAS, when it registered the peak value. Further it showed a declining trend. The genotype registered peak harvest index and oil percentage at the final harvest. Both the parameters showed progressive increase with regard to time of harvest upto 110 DAS.

The vegetative growth of plant continued upto 110 DAS hence the continuous increase in plant height till the final harvest. However the plant growth in terms of number of mature pods continued only upto 100 DAS and ceased thereafter (Tisdale et al., 1985). The behaviour of the percentage of mature pods, 100 pod weight, 100 kernel weight and sound mature kernel percentage may be attributed to similar reasons as detailed under the genotype BPG 521. The apparent steadiness in shelling percentage manifested during the second harvest interval may be due to a probable increase in the thickness of shells during this stage, aided by better accumulation of metabolites into it. (Bunting and Anderson, 1960). The increase in shelling percentage during the first and third harvest intervals may be attributed to increase in the 100 kernel weight during the respective periods

(Khan and Akosu, 1971). Further increase manifested by this parameter during the final harvest interval may be explained in terms of a favourable kernel to pod ratio by weight created due to deterioration of shell of pods influenced by the environment.

The increase in pod yield with regard to time of harvest may be attributed to a corresponding increase in the performance of number of mature pods, percentage of mature pods, 100 pod weight, 100 kernel weight, sound mature kernel percentage and shelling percentage. The decline in pod yield after 100 DAS may be attributed to a corresponding decline in 100 pod weight, 100 kernel weight and sound mature kernel percentage.

The genotype can be said to have attained optimum physiological maturity at 100 DAS due to realisation of maximum pod yield in association with the peak performance of component characters like number of mature pods, 100 pod weight, 100 kernel weight and sound mature kernel percentage. Fairly high oil percentage was also realised at the time of optimum maturity.

TG 3

The variation of pod yield and component characters of the genotype TG 3 is presented in figure 13.

A perusal of the data in table 8 shows that the genotype attained maximum plant height at 90 DAS. The number of mature pods reached a maximum at 110 DAS, eventhough this was found to be on par with that recorded at 100 DAS. The maximum percentage of mature pods was attained at the final harvest. The parameter showed an initial decline in value followed by successive increases during subsequent harvest intervals. The increased was at a comparatively faster rate between 80 and 90 DAS. The pod yield registered its peak at 100 DAS. It followed a more or less similar pattern of variation as number of mature pods from 70 to 100 DAS, but however declined thereafter. Similar to percentage of mature pods, pod yield also showed a comparatively faster rate of increase between 80 and 90 DAS. The 100 pod weight and 100 kernel weight followed a more or less similar pattern of variation as pod yield from the second to the final harvest and in the meanwhile registered peak performance at 100 DAS. They however declined in value during the first harvest interval. Shelling percentage also followed a similar pattern of variation

The increase in pod yield upto 100 DAS may be attributed to an increase in the number of mature pods upto 80 DAS, and a corresponding increase exhibited by the other component characters viz. percentage of mature pods, 100 pod weight, 100 kernel weight, sound mature kernel percentage and shelling percentage from 80 to 100 DAS. The decline in the value of the parameter after 100 DAS may be attributed to a corresponding decline in the value of 100 pod weight, 100 kernel weight and sound mature kernel percentage due to reasons discussed earlier.

Hundred DAS may be regarded as the time of optimum maturity for this genotype due to attainment of maximum pod yield and optimum/peak values for associated characters like number of mature pods, 100 pod weight, 100 kernel weight and sound mature kernel percentage. The genotype also recorded fairly high oil content at the time of optimum maturity.

TG 14

The variation of yield and component characters of the genotype TG 14 (yield check) is presented in figure 14.

A perusal of the data given in table 8 shows that the genotype attained significant increase in plant height only upto 90 DAS although the peak value was registered at 110 DAS. The number of mature pods registered progressive increase in value upto 100 DAS when it recorded the highest value, and remained unchanged thereafter. The peak value for percentage of mature pods was attained at the final harvest. Both the above parameters registered a comparatively faster rate of increase between 80 and 90 DAS. However the percentage of mature pods showed an initial decline during the first harvest interval. The pod yield also followed an almost similar pattern of variation as the number of mature pods upto 100 DAS, when it recorded the peak value. Beyond 100 DAS, however, the parameter showed a significant declining trend. The 100 pod weight also attained its peak value at 100 DAS, after which it declined. This peak was attained through an initial decline in value upto 80 DAS, followed by sudden spurts during the subsequent two harvest intervals. The 100 kernel weight also followed a more or less similar pattern of variation as 100 pod weight and attained peak value at 100 DAS. The genotype recorded the peak shelling percentage also at 100 DAS. In its course this parameter recorded an initial decline in value followed by an appreciable increase upto 90 DAS remained without any significant change till 100 DAS and then again increased to record the peak value at the final harvest. The maximum sound mature kernel percentage for the genotype was also registered at 100 DAS. The parameter in fact followed a more or less similar pattern of variation as 100 pod weight and 100 kernel weight with regard to time of harvest. The genotype registered the maximum haulms yield at 90 DAS whereafter it declined. The final harvest witnessed attainment of peak values of harvest index and oil percentage. Both the parameters showed progressive increase in value with respect to time of harvest upto 110 DAS.

The behaviour of characters viz., plant height, number and percentage of mature pods, 100 pod weight, 100 kernel weight, sound mature kernel percentage and shelling percentage with respect to time of harvest may be attributed to similar reasons as detailed under the genotype IES 881.

The increase in pod yield manifested upto 100 DAS may be attributed to a corresponding increase in the number of mature pods, percentage of mature pods, 100 pod weight, 100 kernel weight, sound mature kernel percentage, shelling percentage and harvest index.

The increase in the parameter during the first harvest interval may solely be attributed to the number of mature pods, since all other parameters declined in value during this period. Between 80 and 100 DAS all the above component characters were on an increasing trend. This might have been the reason for a rapid rate of increase in value of the pod yield after 80 DAS. The decline in pod yield after 100 DAS may be attributed to a corresponding decline in the value of the 100 pod weight, 100 kernel weight and sound mature kernel percentage.

The genotype may be considered to have attained optimum physiological maturity at 100 DAS, since peak values were attained by pod yield and other maturity related components viz., number of mature pods, 100 pod weight, 100 kernel weight and sound mature kernel percentage. The genotype also gave fairly high oil percentage at maturity.

Chico

The variation of yield and component characters of the genotype chico is given in figure 15.

A perusal of the data in table 8 shows that the genotype showed significant increase in the plant height only upto 90 DAS although the maximum value was recorded at 100 DAS. The number of mature pods recorded maximum value at 80 DAS. It increased significantly during the first harvest interval, kept almost steady till 90 DAS and then declined significantly. The percentage of mature pods showed gradual increase during the first two harvest intervals, attained a peak at 90 DAS and the declined. An increase in pod yield was manifested from 70 to 80 DAS, after which it declined significantly with time of harvest. The 100 pod weight also registered its peak performance at 80 DAS. It registered spurt in value during the first harvest interval, attained the peak value and declined thereafter. The 100 kernel weight also followed a similar pattern of variation as 100 pod weight and in the process attained peak value at 80 DAS. The shelling percentage and sound mature kernel percentage also followed roughly similar trends as of 100 pod weight and 100 kernel weight. Both these parameters too recorded peak values at 80 DAS. Haulms yield however showed continuous decline from 70 to 110 DAS. Maximum harvest index was obtained at the 100 DAS and maximum oil percentage at 90 DAS.

From the results it can be understood that the genotype attained growth cessation with respect to plant height, at 90 DAS and with regard to number of mature pods at 80 DAS (Tisdale et al., 1985). The increase in the percentage of mature pods from 80 to 90 DAS may be the result of a favourable ratio of number of mature pods to total number of pods created due to deterioration of immature pods owing to shortage of assimilates (Bunting and Elsten, 1980). The drastic decline in the number of mature pods after 90 DAS may be the result of deterioration of pods under the influence of environmental factors, on account of the pods being left in the field for long, after attainment of optimum maturity (Reddy, 1988). The increase in 100 pod weight and 100 kernel weight upto 80 DAS may be explained as a manifestation of increased photosynthetic efficiency, effective translocation and better accumulation of photosynthates into the kernels (Bunting and Anderson, 1960 and Khan and Akosu, 1971), and their decline thereafter to similar reasons attributed earlier. The decline in shelling percentage after 80 DAS may be explained as a manifestation of the decline in the weight of kernels during the corresponding period.

The increase in pod yield during the first harvest interval may be attributed to a corresponding increase in the number of mature pods, percentage of mature pods, 100 pod weight, 100 kernel weight, sound mature kernel percentage and shelling percentage. The decline in pod yield after 80 DAS may be attributed to the decline in 100 pod weight, 100 kernel weight, sound mature kernel percentage and shelling percentage. The progressive decline in haulms yield from the first to the last harvest suggest that the vegetative growth had ceased at 70 DAS indicating the crop was nearing maturity (Enyi, 1977).

The genotype may be considered to have attained optimum physiological maturity at 80 DAS due to the attainment of maximum pod yield and peak values of component characters like number of mature pods, 100 pod weight, 100 kernel weight, sound mature kernel percentage and shelling percentage.

In general, it can be noted that almost all the genotypes gave fairly high oil percentage when harvested at the time of optimum maturity. So also, the time of optimum maturity occurred soon after the cessation of vegetative growth, manifested in terms of haulms yield. The termination of vegetative growth might have facilitated more photosynthates being available for accumulation into the pods; thereby realisation of peak yield(Enyi,1977)

In the light of the above discussion, the different genotypes can be classified under three discrete groups based on time of optimum physiological maturity as under

(i) Those maturing at 80 DAS

Chico

(ii) Those maturing at 90 DAS

IES 882, IES 883, IES, 885, ICGS(E) 21, ICGS(E) 52, ICGS(E) 121, Dh(E) 20, Dh(E) 32

(iii) Those maturing at 100 DAS

IES 881, BPG 521, JL 24, TMV 2, TG 3, TG 14

The need for suitable time bound varieties for inclusion in the summer rice fallows of Kerala necessitates the selection of superior genotypes from among those maturing at 90 DAS. Since the present-day focus rests on increasing productivity with respect to time and space, early maturity coupled with high pod yield and maturity related yield components forms our major concern.

The variation among genotypes with regard to pod yield and maturity related yield components at 90 DAS is presented in table 9 and illustrated in figure 17. Based on these, the genotypes maturing at 90 DAS and the checks may be ranked in the descending order of their performance with respect to the above parameters as follows.

Table- 9. Performance of maturity related component characters of 15 groundnut genotypes at 90 DAS

Sl. No.	Genotypes	Pod yield (g/ plant)	No. of mature pods	100 pod weight (g)	100 Kernal weight (g)	Shelling percentage *	SMK per cent age *
1.	IES 881	11.17	12.15	88.50	37.01	61.99	65.49
2.	IES 882	12.67	14.33	81.30	34.15	60.34	66.50
3.	IES 883	12.00	14.33	88.27	36.19	58.88	68.73
4.	IES 885	10.95	13.13	84.78	34.76	54.76	69.54
5.	ICGS(E)21	11.95	14.05	82.95	33.18	54.02	65.50
6.	ICGS(E)52	12.85	15.03	88.58	38.09	61.15	68.10
7.	ICGS(E)121	11.92	13.88	88.83	38.20	58.28	57.09
8.	Dh(E)20	10.90	13.13	78.65	31.46	59.82	67.45
9.	Dh(E)32	11.15	13.88	76.77	31.48	59.87	68.05
10.	BPG 521	8.35	9.40	87.13	36.59	58.50	65.68
11.	JL 24	10.91	9.99	89.95	37.78	58.42	63.43
12.	TMV 2	8.99	12.00	80.35	34.55	55.60	64.89
13.	TC 3	11.13	11.78	90.45	38.99	56.25	66.18
14.	TG 14	11.76	12.01	100.10	43.04	61.10	62.01
15.	Chico	9.20	19.01	53.03	22.80	54.50	68.99
	F	43.06**	7.05**	97.15**	44.31**	25.73**	71.52**
	SE(gh) ±	0.251	0.390	1.003	0.519	0.548	0.442
	CD(0.05)	0.698	1.088	2.781	1.439	1.518	1.224
	cv(gh)	2.727	3.304	1.326	1.364	0.968	0.707

* Arc sine transformed values
** Significant at 1% level
g _genotypes
h - days of harvest

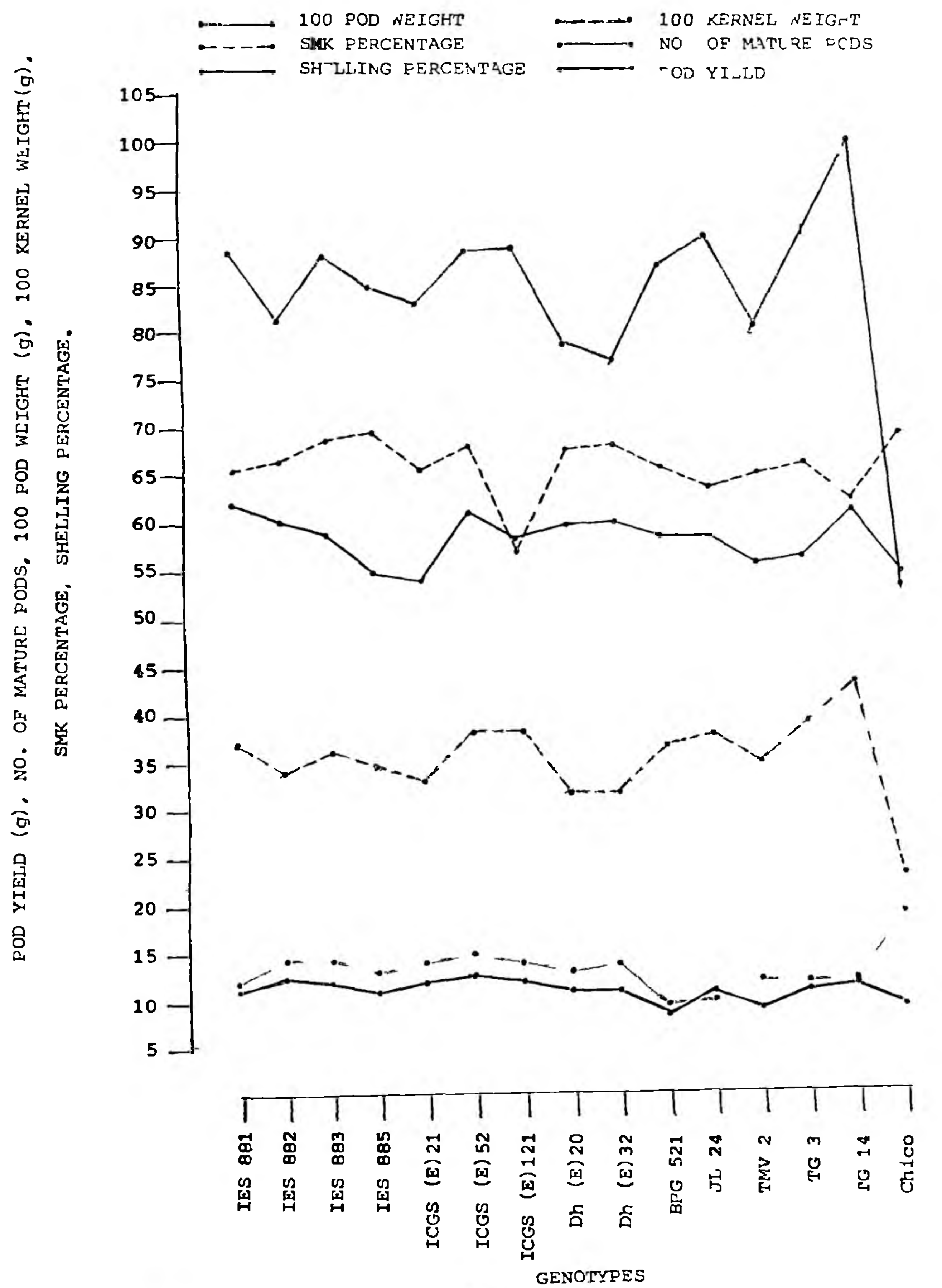

Fig. 17 . Variation of maturity related component characters among 15 groundnut genotypes at 90 DAS

POD YIELD

ICGS(E)52, IES 882, IES 883, ICGS(E)21, ICGS(E)121, TG 14, Dh(E)32, IES 885, JL 24, Dh(E) 20,Chico

NUMBER OF MATURE PODS

Chico, ICGS(E) 52, IES 882, IES 883, ICGS(E)21, ICGS(E) 121, Dh(E)32, IES 885, Dh(E)20, TG 14, JL 24

100 POD WEIGHT

TG 14, JL 24, ICGS(E) 121, ICGS(E)52, IES 883, IES 885, ICGS(E)21, IES 882, Dh(E)20, Dh(E)32 Chico

100 KERNEL WEIGHT

TG 14, ICGS(E)121, ICGS(E)52, JL 24, IES 883, IES 885, IES 882, ICGS(E)21, Dh(E)32, Dh(E)20, Chico

SHELLING PERCENTAGE

ICGS(E)52, TG 14, IES 882, Dh(E)32, Dh(E)20, IES 883, JL 24, ICGS(E)121, IES 885, Chico, ICGS(E)21

SOUND MATURE KERNEL PERCENTAGE

IES 885, Chico, IES 883, ICGS(E)52, Dh(E)32, Dh(E)20, IES 882, ICGS(E)21,JL 24,TG 14,ICGS(E)121

(Ranking done based on critical difference, in the descending order of value)

The above ranking may further be modified by grouping together the genotypes showing on par performance with respect to each character, and the following more precise ranking may be arrived at

POD YIELD

(1) ICGS(E)52, IES 882

(2) IES 883, ICGS(E)21, ICGS(E)121, TG 14

(3) Dh(E) 32, IES 885, JL 24, Dh(E) 20

(4) Chico

NUMBER OF MATURE PODS

1. Chico
2. ICGS(E)52, IES 882, IES 883, ICGS(E) 21
3. ICGS(E)121, Dh(E) 32, IES 885, Dh(E) 20
4. TG 14
5. JL 24

100 POD WEIGHT

1. TG 14
2. JL 24, ICGS(E) 121, ICGS(E) 52, IES 883
3. IES 885, ICGS(E) 21
4. IES 882, Dh(E) 20
5. Dh(E) 32
6. Chico

100 KERNEL WEIGHT

1. TG 14
2. ICGS(E) 121, ICGS(E) 52, JL 24
3. IES 883, IES 885
4. IES 882, ICGS(E) 21
5. Dh(E) 32, Dh(E) 20
6. Chico

SHELLING PERCENTAGE

1. ICGS(E) 52, TG 14, IES 882, Dh(E) 32, Dh(E) 20
2. IES 883, JL 24, ICGS(E) 121.
3. IES 885, Chico, ICGS(E) 21

SOUND MATURE KERNEL PERCENTAGE

1. IES 885, Chico, IES 883
2. ICGS(E) 52, Dh(E) 32
3. Dh(E) 20, IES 882
4. ICGS(E) 21
5. JL 24, TG 14
6. ICGS(E) 121

(Checks are underlined)

Decisions taken jointly on a number of component characters are more representative than those taken on the basis of pod yield alone (Arunachalam and Bandyopadhyay, 1984). Hence to easily identify the superior genotypes, a logical scoring system with unit(1) and nil (0) scores may be adopted for each character. If the genotype ranks first or second for a given character, it may be given a unit score for that character. For all other ranks the nil score may be given. Utilising such a scoring system the following scorecard can be obtained.

Genotypes	Scores						
	Pod yield	Number of mature pods	100 pod weight	100 kernel weight	Shelling percentage	SMK percentage	Total scores
IES 882	1	1	0	0	1	0	3
IES 883	1	1	1	0	1	1	5
IES 885	0	0	0	0	0	1	1
ICGS(E)21	1	1	0	0	0	0	2
ICGS(E)52	1	1	1	1	1	1	6
ICGS(E)121	1	0	1	1	1	0	4
Dh(E)20	0	0	0	0	1	0	1
Dh(E)32	0	0	0	0	1	1	2
Checks							
JL 24 (yield)	0	0	1	1	1	0	3
TG 14 (yield)	1	0	1	1	1	0	4
Chico (duration)	0	1	0	0	0	1	2

A perusal of the score-card clearly shows that the genotype ICGS(E) 52 and IES 883 gave most superior performance with respect to yield and maturity related yield components among the different genotypes studied, including the yield and duration checks, at 90 DAS. Thus ICGS(E) 52 and IES 883 are found to be early maturing and high yielding. A concrete recommendation can be made for summer rice fallows after repeating the trial during the summer season.

The important features of the selected genotypes may be summed up as follows

Sl.No.	Characters	Values ICGS(E) 52	IES 883
1.	Height of plant (cm)	48.40	61.75
2.	Days to flower	21.67	21.75
3.	Number of primaries	6.83	6.83
4.	Number of secondaries	4.91	4.91
5.	Number of mature pods	15.03	14.33
6.	Percentage of mature pods	58.41	61.76
7.	Pod yield (g/plant)	12.85	12.00
8.	100 pod weight (g)	88.58	88.27
9.	100 kernel weight (g)	38.09	36.19
10.	Shelling percentage	61.15	58.88
11.	SMK percentage	68.10	68.73
12.	Haulms yield (g/plant)	76.23	66.12
13.	Harvest index	0.20	0.21
14.	Oil percentage	44.30	42.15

SUMMARY

SUMMARY

A field experiment was conducted at the Department of Plant Breeding, College of Agriculture, Vellayani during kharif 1988 with the following objectives.

(i) Analysis of maturity related component characters in groundnut in staggered harvests.

(ii) Determination of time of optimum maturity of genotypes and

(iii) Identification of early maturing genotypes.

Twelve test genotypes were utilised for the study. JL 24 and TG 14 were used as yield checks and Chico as the duration check. The experiment was laid out in a split plot design with five days of harvest in main plots and fifteen groundnut genotypes in sub-plots giving 4 replications. Staggered system of harvesting was adopted wherein the genotypes were harvested at 70, 80, 90, 100 and 110 DAS and a set of characters studied. The important characters studied in each harvest included plant height, number of primary and secondary branches, number of mature pods, percentage of mature pods, pod yield, 100 pod weight, 100 kernel

weight, shelling percentage, sound mature kernel percentage, haulms yield, harvest index and oil percentage. The observations on the various parameters were statistically analysed,and the results obtained are summarised below.

The time of harvest had significant influence on all the characters studied. The genotypes also exerted significant influence on these characters. The genotype x environmental interaction was also significant for all the characters except for the number of branches.

The plant height increased with delay in the time of harvest until a plateau was achieved,after which no significant change occurred to this parameter. Majority of the genotypes showed significant increase in plant height upto 90 DAS and showed no further change thereafter.

The number of primary and secondary branches increased upto 80 DAS and remained unchanged thereafter. However genotype x environmental interaction for this character was non-significant.

The number of mature pods per plant showed progressive increase with delay in the time of harvest, attained a plateau and showed no further significant change thereafter. The genotypes IES 882, IES 883, IES 885, ICGS(E) 21, ICGS(E) 52, ICGS(E) 121, Dh(E) 20 and Dh(E) 32 showed significant increase in the number of mature pods upto 90 DAS, while the genotypes IES 881, BPG 521, JL 24, TMV 2, TG 3 and TG 14 showed increase in this parameter upto 100 DAS. The maximum value for this character was recorded by the genotype Chico.

The percentage of mature pods showed continuous increase in value for all the genotypes from the first to the final harvest. The maximum value for this character was recorded by IES 885 at 110 DAS.

The pod yield per plant progressively increased in value with regard to time of harvest, attained a peak value, and declined when the harvest was further delayed. The genotypes IES 882, IES 883, IES 885, ICGS(E) 21, ICGS(E) 52, ICGS(E) 121, Dh(E) 20 and Dh(E) 32 attained peak performance with regard to this parameter at 90 DAS. The genotypes IES 881, BPG 521, JL 24 (yield check) TMV 2, TG 3 and TG 14 (yield check) however recorded peak pod yield at 100 DAS. Chico, the duration check recorded maximum pod yield at 80 DAS. The highest pod yield was recorded by ICGS(E) 52 at 90 DAS and TG 14 at 100 DAS.

The 100 pod weight and 100 kernel weight followed an almost similar pattern of variation with respect to time of harvest. The parameters showed progressive increase in value with respect to time, attained a peak, and declined thereafter. The genotypes IES 882, IES 883, IES 885, ICGS(E)21, ICGS(E)52, ICGS(E) 121, Dh(E) 20 and Dh(E) 32 recorded peak values for the above parameters at 90 DAS. However, harvest at 100 DAS witnessed peak 100 pod weight and 100 kernel weight for the genotypes IES 881, JL 24 TMV 2, TG 3 and TG 14. Chico gave peak performance for the above parameters at 80 DAS. TG 14 proved the most superior among all genotypes with regard to these parameters.

Shelling percentage showed an irregular pattern of variation with regard to time of harvest. The pooled data however showed a progressive increase in value of this parameter from the first to the final harvest. The genotype IES 881 gave the highest shelling percentage at 90 DAS and the genotype JL 24 at 100 DAS.

Sound mature kernel percentage followed a more or less similar pattern of variation as pod yield, 100 pod weight and 100 kernel weight with regard to time of harvest. It showed progressive increase in value with delay in the time of harvest, attained a peak value and declined thereafter. The genotypes IES 882, IES 883, IES 885, ICGS(E) 21, ICGS(E) 52, ICGS(E) 121, Dh(E) 20 and Dh(E) 32 registered peak performance for this parameter at 90 DAS, while JL 24, TMV 2, TG 3 and TG 14 at 100 DAS. IES 881, however, performed maximum at the final harvest. Chico gave peak value for the above parameter at 80 DAS.

Haulms yield expressed a rapid increase in value during the initial harvest intervals attained a peak value and declined early, prior to the attainment of peak values by pod yield and other maturity related economic characters. The genotypes IES 882, IES 883, IES 885, ICGS(E) 21, ICGS(E) 52, ICGS(E) 121, Dh(E)20 and Dh(E) 32 gave peak haulms yield at 80 DAS and IES 881, JL 24, TMV 2, TG 3 and TG 14 at 90 DAS. Chico, the duration check however showed progressive decline in value of this parameter from the first to the final harvest. Among all the genotypes TG 14 gave the maximum haulms yield.

Harvest index also increased progressively with regard to the time of harvest, attained a plateau and remained steady or declined. Peak harvest index for IES 882, IES 883, ICGS(E) 21, ICGS(E) 52, ICGS(E) 121 and Dh(E) 20 was attained at 90 DAS, for IES 881, IES 885, Dh(E) 32, BPG 521 and Chico at 100 DAS and for JL 24, TMV 2, TG 3 and TG 14 at 110 DAS.

Oil percentage showed progressive increase in value with time of harvest from 70 to 110 DAS. All the genotypes recorded maximum value for this parameter at 110 DAS. The genotype Chico however was an exception recording maximum oil percentage at 90 DAS. The genotype IES 881 gave the highest oil percentage.

The genotypes IES 882, IES 883, IES 885, ICGS(E)21, ICGS(E)52, ICGS(E) 121, Dh(E) 20 and Dh(E) 32 may be considered to have attained optimum physiological maturity at 90 DAS due to attainment of peak or optimum performance for the various maturity related component characters like pod yield, number of mature pods, 100 pod weight, 100 kernel weight, shelling percentage and sound mature kernel percentage.

The genotypes ICGS(E) 52 and IES 883 may be recommended for cultivation in the summer rice fallows due to attainment of early maturity, high yield capability and superior yield attributes like number of mature pods, 100 pod weight, 100 kernel weight, shelling percentage and sound mature kernel percentage.

REFERENCE

REFERENCES

Alam, M.S., Begum, D. and Khair, A.B.M.A. (1985). Study of genetic parameters and character interrelationship in groundnut. Bangladesh J. Agri. Res., 10: 111-7.

Ali, M., Alam, Z. and Khanna, K.L. (1932). Studies on germination and growth in groundnut. Agriculture and Live-stock in India., 3(2): 91-115.

Anon. (1981). ICRISAT Annual Report 1981., pp. 196

Anon. (1985). ICRISAT Annual Report 1985., pp.240-241

Anon. (1989). Package of Practices Recommendations 1989. Kerala Agricultural University, Mannuthy, Kerala., pp. 52-4

Anon. (1990). Farm Guide 1990. Farm Information Bureau, Kerala., pp. 14-19.

Arunachalam, V. and Bandyopadhyay, A. (1984). A method to make decisions jointly on a number of dependant characters. Indian J. Genet. Pl. Breed., 44(3): 419-424.

* Badami, V.K. (1923). Hybridisation work on groundnut. Agricultural Department Report for 1922-23, Mysore, pp. 29-30.

Badwal, S.S. and Gupta, V.P. (1968). Correlations of quantitative traits and selection indices for improving pod yield in groundnut. J. Res. Punjab Agri. Univ., 5: 20-3.

Badwal, S.S. and Singh, H. (1973). Effects of growth habit on correlations and path coefficients in groundnut. Indian J. Genet. Pl. Breed. 33:101-11.

Balaiah, C. and Reddy, P.S. (1976). Heritability estimates of some quantities characters in the F2 generation of groundnut cross, 'J 11' X 'Gujarat Narrow Leaf Mutant'. Oilseeds J., 4: 37-8.

Balaiah, C., Reddy, P.S. and Reddy, M.V. (1977). Genic analysis in groundnut I. Inheritance studies on 18 morphological characters in crosses with 'Gujarat Narrow leaf Mutant'. Proc. Indian Acad. Sci. 85B., pp.340-50.

Balaiah, C., Reddy, P.S. and Reddy, M.V. (1984). Studies on linkage between six morphological characters in crosses with 'Gujarat Narrow Leaf Mutant' groundnut (Arachis hypogaea L.) Oleagineux., 39: 325-7.

*Balkishan, P. (1979). 'Studies on the genetic parameters in the F_2 generation of eight crosses of groundnut (Arachis hypogaea L.)' M.Sc(Ag.) Thesis, Andra Pradesh Agric. Univ., pp. 91.

Basu, A.K. and Raju, P.C.S. (1969). Genotypic variability in some quantitative characters of groundnut. Science and Culture., 35:408-9.

Basu, M.S., Singh, N.P., Vaddoria, M.A. and Reddy, P.S. (1986). Genetic architecture of yield and its components in groundnut (Arachis hypogaea L.) Annals Agric. Res., 7: 144-8.

Bhargava, P.D., Dixit, P.K., Saxena, D.K. and Bhatia, L.K. (1970). Correlation studies on yield and its components in erect varieties of groundnut (Arachis hypogaea L.). Rajasthan J. Agric. Sci., 1: 64-71.

Bhuiyan, S.A. (1984). Inheritance of plant type in groundnut. Indian J. Genet. Pl. Breed. 44:215-7.

Bunting, A.H. and Anderson, B. (1960). Growth and nutrient uptake of Natal common groundnuts in Tanganyika. J. Agric. Sci., 55: 34-46.

Bunting, A.H. and Elsten, J. (1980). Ecophysiology of growth and adaptation in the groundnut. An essay on structure, partition and adaptation (In) Advances in Legumes Science ., pp. 495-500.

*Cahaner, A. (1978). 'The inheritance of yield components and plant conformation in peanuts. Arachis hypogaea L. ' Ph.D. Thesis, Hebru University, Israel.

Cahaner, A. and Ashri, A. (1974). Vegetative and reproductive development of Virginia type peanut varieties in different stand densities. Crop Sci., 14: 412-6.

Choudhari, S. D. (1985). Variability in growth and yield attributes, photosynthetic rate and translocation in bunch genotypes of groundnut (Arachis hypogaea L.) and their relation to productivity. Mysore J. Agric.Sci., 17: 190.

Cochran, W.G. and Cox, G.M. (1965). Experimental Designs. John Wiley and Sons Inc. New York.

Deshmukh, S.N., Basu, M.S. and Reddy, P.S. (1986). Genetic variability character association and path coefficients of quantitative traits in Virginia bunch varieties of groundnut. Indian J. Agric. Sci., 56: 816-21.

Dholaria, S.J., Joshi, S.N. and Kabaria, M.M. (1973). Selection indices under high and low fertility in groundnut. Madras Agric. J., 60: 1383-93.

Dickens, J.W. and Pattee H.E. (1973). Peanut curing and post-harvest physiology (In) Peanuts- Culture and Uses. American Peanut Research and Education Association Inc. pp. 509-22.

Dixit, P.K., Bharagava, P.D., Saxena, D.K. and Bhatia, L.H. (1970). Estimate of genetic variability of some quantitative characters in groundnut (Arachis hypogaea L.) Indian J. Agric. Sci., 40: 197-202.

Dixit, P.K., Bhargava, P.D., Saxena, D.K., Bhatia, L.H. and Sharma, K.N. (1971). Variability in groundnut (Arachis hypogaea L.) Indian Agric. Sci., 41: 685-91.

Donald, D. (1984). The ICRISAT Groundnut program. Proceedings of the Regional Groundnut Workshop for South Africa., pp.28

Dorairaj, M.S. (1962). Preliminary steps for the formulation of selection index for yield in groundnut (Arachis hypogaea L.) Madras Agric. J., 49: 12-27.

Duncan, W.G., Mc Cloud, D.E., Mc Graw, R.L. and Boote, K.J. (1978). Physiological aspects of peanut yield improvement. Crop Sci., 18: 1015-20.

Enyi, B.A.C. (1977). Physiology of grain yield in groundnut. Experimental Agriculture., 13: 101-10.

*Forestier, J. (1973). Vegetative characters, growth and yield of early groundnuts in a forest region. Cahorstom Biologic., 19: 43-62.

*Gregory, W.C., Smith, B.W. and Yarbrough, J.A. (1951). Morphology, genetics and breeding. (In) The Peanut- The Unpredictable Legume. National Fertilizer Association, Washington, D.C., pp. 28-88.

Gupton, C.L. and Emery, D.A. (1970). Heritability estimates of the maturity of fruits from specific growth periods in Virginia peanuts (*Arachis hypogaea* L.). Crop Sci., 10: 127-9.

*Hassan, M.A. (1964). 'Genetic, floral, biological and maturity studies in groundnut: M.Sc.Thesis, Ranchi Agric. College. Ranchi Univ. Bihar.

Henning, R.J., Brown, R.H. and Ashley, D.A. (1979). Effects of leaf position and plantage on photosynthesis and translocation in peanut. I. Apparent photosynthesis andC translocation. Peanut Science., 6: 46-50.

*Hull, F.M. (1937). Inheritance of rest period of seeds and certain other characters. Florida Agricultural Experiment Station Bulletin., pp.314.

Ibrahim, A.E.S. (1983). Associations, path analysis and multiple coefficients of determination of some yield components in groundnut (*Arachis hypogaea* L.). Oleagineux., 38: 323-9.

John, C.M. (1949). Report on research on oilseed crops in India. The Indian Central Oilseeds Committee. New Delhi. Appendix. III., p.xix.

Kandaswami, M., Soundarapandyan, G. and Kadambavanasundaram, M. (1986). Genetic variability and genotype-environment interaction in some quantitative characters of *Arachis hypogaea* L. Madras Agric. J., 73:301-7.

Kartha, A.R.S. and Sethi, A.S. (1957). A cold percolation method for rapid gravimetric estimation of oil in small quantities of oilseeds. Indian J. Agric. Sci., 27: 217.

Kataria, V.P., Rao, S.K. and Kushwaha, J.S. (1984). Yield components in bunch type of groundnut. Mysore J. Agric. Sci., 18: 13-6.

*Kawakami, J. (1930). Chromosome numbers in leguminosae. Botanical Magazine, Tokyo., 44: 319-28.

Khan, A.A. and Akosu, F.I. (1971). The physiology of groundnut. I. An autoradiographic study of the pattern of distribution of 14 carbon products. Physiologia Plantarum., 24: 471-5.

Khangura, B.S. and Sandhu, R.S. (1972). Path analysis in groundnut (Arachis hypogaea L.) Indian J. Agric. Sci. 42: 792-5.

*Kohler, E. (1898). Medizinal- Pflanzen; Bearbeit. M.Vogtherr and M.Murke, Band III Gera.

*Krapovickas, A. (1968). Origen, variabilidad y difusion del mani (Arachis hypogaea) Actas y Memorias, Congress International Americanistas., 2: 517-34.

*Krapovickas, A. and Rigoni, V.A. (1960). La nomenclatura de las subspecies y variedades de Arachis hypogaea L. Revista de Investigaciones agricolas., 14: 197-228.

Kulkarni, G.N. and Albuquerque, S.D.S. (1967). Study of variation in some quantitative characters of nine strains of groundnut evolved at Raichur. Mysore J. Agric. Sci., 1: 53-9.

Kumar, P. and Yadava, T.P. (1979). Estimates of variation and heritability in groundnut. J. Res. Haryana Agric. Univ. 9: 231-4.

Kumar, P., Yadava, T.P. and Gupta, S.C. (1984). Stability analysis in bunch group of groundnut. J. Res. Haryana Agric. Univ. 14: 180-3.

Kushwaha, J.S. and Tawar, M.C. (1973). Estimates of genotypic and phenotypic variability in groundnut (Arachis hypogaea L.) Indian J. Agri. Sci., 43:1049-54.

*Lakshmaiah (1978). 'Studies on the relationship between yield and its components in groundnut (Arachis hypogaea L.). M.Sc.(Ag) Thesis, Andra Pradesh Agric. Univ. Andra Pradesh.

Lakshmaiah, B. Reddy, P.S. and Reddy, B.M. (1983). Selection criteria for improving yield in groundnut (Arachis hypogaea L.) Oleagineux 38: 607-13.

*Lin, H., Chen, C.C. and Lin, C.Y. (1969). Studies on the yield components of peanut. II. The path coefficient of yield components in different crops of peanut. J. Agric. Assoc. China. 65: 22-31.

Linnaeus, C. (1753). Species Plantarum. Holmiae., 2: 741.

Mahapatra, L.N. (1966). Preliminary studies on correlation of yield with other characters of groundnut. Indian Agric., 10(2):97-106.

Majumdar, P.K., Prakash, R. and Haque, M.F. (1969). Genotypic and phenotypic variability in quantitative characters in groundnut. Indian J. Genet. Pl. Breed. 29: 291-6.

Majumdar, P.K., Prakash, R. and Hassan, M.A. (1970). Notes on indices of maturity in groundnut (Arachis hypogaea L.) varieties. Indian J. Agric. Sci., 40: 292-3.

Matrin, J.P. (1967). A contribution to the study of certain hereditary characters of agronomic importance in groundnut. Oleagineux., 22: 673-6.

Mc Cloud, D.E. (1974). Growth analysis of high yielding peanuts.Proc. Soil Crop Sci. Soc.Florida., 33: 24-6.

Miller, I.L. and Norden, A.J. (1980). Relationship of yield, maturity and susceptibility to leaf spot diseases in peanut (Arachis hypogaea L.) Agron.Abst. American Society of Agronomy,pp.62.

Mohammed, S.V., Ramanathan, T., Ramachandran, M. and Babu, G.M. (1973). Variation in kernel weight and shelling out-turn in Arachis hypogaea L. Madras Agric. J., 60:1394-8.

Mohan, J.C. Ali, A.M. and Subramanian, C. (1967). Correlation ofcertain quantitative characters with yield in the strain TMV 2. Madras Agric. J., 54: 482-4.

Mouli, C. and Kale, D.M. (1982). An early maturing groundnut with foliaceous stipule marker. Current Sci., 51:132-4.

Nadaf, H.L., Habib, A.F. and Goud, J.V. (1986). Analysis of genetic diversity in bunch groundnut. J. Oilseeds. Res. 3: 37-45.

*Nagabhushanam, C V.S. (1981). 'Studies on the estimates of genotypic and phenotypic variability and analysis of character association in certain Spanish and Valencia genotypes of groundnut (Arachis hypogaea L.)'. M.Sc.(Ag) Andra Pradesh Agri. Univ. Hyderabad. Andra Pradesh.

Natarajan, S.T., Sathiamoortny, M.R., Venkateswaran, A.N. and Ramachandran, T.K. (1978). Estimates of the genetic parameters and correlation studies in bunch groundnut. Madras Agric. J., 65: 497-501.

Nigam, S.N., Dwivedi, S.L., Sigamani, T.S.N. and Gibbons, R.W. (1984). Character association among vegetative and reproductive traits in advanced generation of intersubspecific crosses in peanut. Peanut Science., 11: 95-8.

Norden, A.J., Gorbet, D.W. Knauft, D.A. and Martin, F.G. (1986). Genotypic x environmental interactions in peanut multiline populations. Crop Sci., 26: 46-8.

Patel, N.V. (1988). Distribution, area, production and trade (In) Groundnut. Indian Council of Agricultural Research, New Delhi., pp.12-23.

Patel, J.S., John, C.M. and Seshadri, C.R. (1936). The inheritance of characters in the groundnut Arachis hypogaea L. Proc. Indian Acad. Sci., 3: 214-33.

Patra, G.J. (1975). Heritability and genetic advance of some quantitative characters in groundnut hybrids in F_8 generation. Indian J. Agric. Sci., 45: 308-11.

Qadri, M.I. and Khunti, V.P. (1982). Genetic variability in bunch groundnut. Crop Improvement., 9: 98-100.

*Raju, P.R.K. (1978). 'Studies on combining ability and other inter-related aspects in certain crosses of groundnut (Arachis hypogaea L.)'. M.Sc.(Ag)Thesis, Andra Pradesh Agri. Univ. Hyderabad., pp.69.

Raman, V.S. and Rangaswamy, S.R.S. (1970). Genetic variability of quantitative attributes in the progenies of the hybrid Arachis hypogaea x Arachis monticola. Madras Agric. J., 57:571-7.

Rao, M.J.V. and Gibbons, R.W. (1984). Breeding for earliness.(In) ICRISAT Annual Report 1984., pp.226-229.

Rao, T.S. (1978/79). Heritable variation and inter-relationships of economic characters in groundnut. Genetica Iberica., 30/31: 257-60

Rao, T.S. (1979a). Genetic variability in groundnut. Crop Improvement., 6: 66-7.

Rao, T.S. (1979b). Assessment of the genetic variation in bunch groundnut., Crop Improvement., 6: 172-4.

Rao, V.N. (1936). A note on preliminary physiological observations on the groundnut. Proc. Assoc. Econ. Biol. Coimbatore., pp.1-6.

Reddy, P.R. (1988a) Growth and development (In) Groundnut. Indian Council of Agricultural Research, New Delhi., pp.78-118.

Reddy, G.H.S. (1988) . Cultivation, storage and marketing. (In) Groundnut. Indian Council of Agricultural Research, New Delhi., pp.318-83.

*Richter, C.G. (1899). Beitrage zur Biologie von Arachis hypogaea. A. Schrieber (Ed.) Inaug.Diss. Kgl. Bot. Gart. Breslau., pp.39.

*Samooro, B. (1975). 'Inheritance of pod size, shell thickness and seed maturity in peanuts, Arachis hypogaea L.' Ph.D.Thesis, Oklahoma State Univ. USA.

Sandhu, B.S. and Khehra, A.S. (1975). Genetic analysis of the number and length of the primary and secondary branches in groundnut. Crop Improvement., 2: 90-8.

Sandhu, B.S. and Khehra, A.S. (1976). The role of epistasis in the inheritance of yield and its components in groundnut. Crop Improvement., 3: 9-17.

Sandhu, B.S. and Khehra, A.S. (1977). Inter-relationships on semi-spreading x bunch and semi-spreading x semi-spreading crosses of groundnut. Indian J. Genet. Pl. Breed., 37: 22-6.

Sangha, A.S. (1973). Genetic variability and correlation studies in spreading groundnut varieties (Arachis hypogaea L.) Madras Agric. J. 60: 1446-52.

Sangha, A.S. and Sandhu, R.S. (1974). Genetic variability and correlation studies in bunch groundnut. Oilseeds. J., 4: 22-30.

Sangha, A.S. and Sandhu, R.S. (1975). Variability and correlation studies in spreading groundnut. Oilseeds. J., 5: 5-8.

Sashidhar, V.R., Mekhri, A.A. and Sastry, K.S.K. (1977). Proline accumulation in relation to seed hardening in groundnut genotypes. Indian J. Agric. Sci., 47: 595-8.

Seshadri, C.R. (1962). Groundnut. Indian J. Pl. Physiol., 11: 158-63.

*Shany, G. (1977). 'Protein and oil in seeds of peanut (Arachis hypogaea L.) cultivars and hybrids; content, heritability and correlations with some yield characters'. M.S Thesis, Hebru Univ. Israel.

Singh, M., Labana, K.S. and Singh, B. (1984). Correlation and path analysis in groundnut. Crop Improvement., 11: 150-2.

Singh, D.D., Singh, I.S., Singh, H., Singh, S.P. and Singh, A.B. (1971). Diallel analysis in yellow sarson (Brassicus campestris L.) variety, Prain. Indian J. Agric. Sci. 41(4): 315-323.

Singh, H., Yadav, A.K., Yadava, T.P. and Chhabra, M.L. (1982). Genetic variability and heritability for morpho-physiological attributes in groundnut. Indian J. Agric. Sci., 52: 432 - 4.

Sivasubramanian, P., Ramanathan, T., Mahalingam, R. Prasad, K.N.S. and Adhivaraham, D. (1977). Genetic variability in certain metric traits of Arachis hypogaea L. Madras Agric. J., 64: 447-50.

Smartt, J. (1976). Tropical Pulses. Longman, London.

Tai, P.Y.P. and Young, C.T. (1977). Inheritance of drymatter deposition and free arginine in maturing peanuts, Arachis hypogaea L. Peanut Sci., 4: 1-6.

Tisdale, S.L., Nelson, W.L. and Beaton, J.D. (1985). Soil Fertility and Fertilizers. Mac. Millan Publishing Co. Inc., New York. 4th Edn. pp.19-58.

Tiwari, S.P. (1983). Genetic improvement of Rabi-Summer groundnut. Paper presented at the Summer Institute on 'Recent Advances in Groundnut Productivity Research' held from 9-30 May 1983 at the National Research Centre for Groundnut, pp.11.

Velu, G., Gopalakrishnan, S. (1985). Habitual and varietal variation in yield, harvest index and quality characters of groundnut. Madras Agric. J. 72: 518-21.

*Waldron, R.A. (1919). The peanut (Arachis hypogaea)- Its history, histology, physiology and utility. Pennsylvania Univ. Bot. Lab. Contrib., 4: 301-38.

Williams, J.H. (1979). The physiology of groundnut (Arachis hypogaea L. cv Egret) IV. The Growth of groundnut, fruit set at the start and end of pod setting. Rhodesian J. Agric. Res., 17: 63-6.

William, J.H., Wilson, J.H.H. and Batte, G.C. (1976). The influence of defoliation and pod removal on growth and drymatter distribution in groundnut (Arachis hypogaea L.) cultivars in Rhodesia. Rhodesian J. Agric. Res. 14: 111-7.

*Wu, S.Z. (1983). Investigation and analysis of the breeding of new groundnut cultivars. Acta agronomica sinica., 9: 215-6.

Yadava, T.P. and Kumar, P. (1978). Phenotypic stability of yield and its components in semi-spreading group of groundnut (Arachis hypogaea L.) Crop Improvement. 5: 45-9.

Yadava, T.P. and Kumar, P. (1979). Studies on genotype-environment interaction for pod yield and maturity in groundnut (Arachis hypogaea L.) J. Res. Haryana Agric. Univ., 9: 226-30.

Yadava, T.P., Kumar, P. and Thakral, S.K. (1984). Association of pod yield with some quantitative traits in bunch group of groundnut (Arachis hypogaea L.) J. Res. Haryana Agric. Univ. 14: 85-8.

Yadava, T.P., Kumar, P. and Yadav A.K. (1981). Correlation and path analysis in groundnut. J. Res. Haryana Agric. Univ. 11: 169-71.

* Original not seen.

APPENDICES

Appendix - I

Weather data during the cropping period (27-6-1988 to 15-10-1988)

Sl. No.	Standard week	Duration From	Duration To	Maximum temperature (°C)	Minimum temperature (°C)	Rainfall (mm)	Relative humidity (%)
1	25	25.6.88	1.7.88	29.2	23.4	6.6	94.5
2	26	2.7.88	8.7.88	30.8	24.2	1.4	89.3
3	27	9.7.88	15.7.88	29.2	23.4	5.8	91.7
4	28	10.7.88	22.7.88	28.2	22.9	16.4	90.3
5	29	23.7.88	29.7.88	28.5	22.9	7.2	87.5
6	30	30.7.88	5.8.88	29.0	23.7	0.6	81.2
7	31	6.8.88	12.8.88	28.8	23.6	3.6	85.1
8	32	13.8.88	19.8.88	29.1	23.2	5.6	90.9
9	33	20.8.88	26.8.88	29.1	23.1	2.8	81.2
10	34	27.8.88	2.9.88	29.7	23.8	0.0	80.1
11	35	3.9.88	9.9.88	29.5	23.7	7.4	79.6
12	36	10.9.88	16.9.88	29.3	23.5	7.8	83.6
13	37	17.9.88	23.9.88	29.0	23.5	0.8	86.4
14	38	24.9.88	30.9.88	29.6	24.0	6.2	82.6
15	39	1.10.88	7.10.88	30.4	23.7	6.4	82.1
16	40	8.10.88	14.10.88	29.5	23.7	3.0	87.3
17	41	15.10.88	21.10.88	29.8	23.8	14.6	86.4
18	42	22.10.88	28.10.88	30.1	23.6	3.4	80.4

ANALYSIS OF MATURITY RELATED CHARACTERS AND IDENTIFICATION OF EARLY MATURING VARIETIES IN GROUNDNUT

BY

SUNIL KUMAR, A. C.

ABSTRACT OF A THESIS

submitted in partial fulfilment of the
requirement for the Degree of
MASTER OF SCIENCE IN AGRICULTURE
Faculty of Agriculture
Kerala Agricultural University

Department of Plant Breeding
COLLEGE OF AGRICULTURE
VELLAYANI, TRIVANDRUM

1990

ABSTRACT

With the intention of identifying suitable superior early maturing genotypes for intensive cultivation in the summer rice fallows of Kerala, a study was conducted for determining the time of optimum physiological maturity of twelve bunch type groundnut genotypes by analysing the various maturity related component characters in staggered harvests. The twelve test genotypes and the yield and duration checks were staggered harvested at 70, 80, 90, 100 and 110 DAS.

The characters that were put to study in each harvest included the height of plant, number and percentage of mature pods, pod yield, 100 pod weight, 100 kernel weight, shelling percentage, percentage of sound mature kernels, haulms yield, harvest index and oil percentage. Analysis of the various parameters in different genotypes indicated that peak pod yield and time of optimum maturity were closely associated with peak performances of components like number of mature pods, 100 pod weight, 100 kernel weight, sound mature kernel percentage and shelling percentage. It was also noted that the genotypes gave fairly high oil percentage at the time of optimum maturity.

The genotypes IES 882, IES 883, IES 885, ICGS(E) 21, ICGS(E) 52, ICGS(E) 121, Dh(E) 20 and Dh(E) 32 attained optimum physiological maturity at 90 DAS due to attainment of peak values for the various maturity related component characters. A critical appraisal however showed that the genotypes ICGS(E) 52 and IES 883 exhibited significantly superior performance over the remaining genotypes and the yield and duration checks at 90 DAS.

The genotypes ICGS(E) 52 and IES 883 may be recommended for intensive cultivation in the summer rice fallows of Kerala owing to realisation of high yield and yield attributes, combined with early maturity. ICGS(E) 52 ranked first with a pod yield 12.85 g per plant, 100 pod weight of 88.6 g and 100 kernel weight of 38.1 g. The genotype IES 883 stood second in performance with a pod yield of 12.00 g per plant, 100 pod weight of 88.3 g and 100 kernel weight of 36.2 g. Both the genotypes exhibited appreciably high performance for shelling percentage and sound mature kernel percentage also.