WATER STRESS IMPOSED GROWTH AND YIELD DYNAMICS OF GROUNDNUT (*Arachis hypogaea L.*)

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B A P A T L A

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By
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CERTIFICATE

Sri C. Ramesh has satisfactorily prosecuted the course of research and that the thesis entitled "WATER STRESS IMPOSED GROWTH AND YIELD DYNAMICS OF GROUNDNUT (Arachis hypogaea L.)" submitted is the result of original research work and is of sufficiently high standard to warrant its presentation to the examination. I also certify that the thesis or part thereof has not been previously submitted by him for a degree of any University.

Date: 27-7-1983.

(Dr. D.V. MADHUSUDANA RAO)
CHAIRMAN AND MAJOR ADVISOR
Plant Physiologist
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CERTIFICATE

This is to certify that the thesis entitled "WATER STRESS IMPOSED GROWTH AND YIELD DYNAMICS OF GROUNDNUT (*Arachis hypogaea* L.)" submitted in partial fulfilment of the requirements for the degree of Master of Science in Agriculture of the Andhra Pradesh Agricultural University, Hyderabad, is a record of the bonafide research work carried by Sri C. Ramesh under my guidance and supervision. The subject of the thesis has been approved by the Student's Advisory Committee.

No part of the thesis has been submitted for any other degree or diploma has been published. Published part has been fully acknowledged. All the assistance and help received during the course of the investigations have been duly acknowledged by him.

(Dr. D.V. MADHUSUDANA RAO)
CHAIRMAN OF THE ADVISORY COMMITTEE

Thesis approved by the Student Advisory Committee

CHAIRMAN (Dr. D.V. MADHUSUDANA RAO)

MEMBER (Dr. V. RAMESH BABU)

MEMBER (Sri K. SUBRAMANYAM REDDY)

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A C K N O W L E D G E M E N T S

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Date: 27-7-1983

(G. RAMESH)

DECLARATION

I, C. Ramesh, hereby declare that the thesis entitled "WATER STRESS IMPOSED GROWTH AND YIELD DYNAMICS OF GROUNDNUT (*Arachis hypogaea* L.)" submitted to the Andhra Pradesh Agricultural University for the degree of Master of Science in Agriculture in the major field of Plant Physiology is the result of original research work done by me. I also declare that any material contained in the thesis has not been published earlier.

Date: 27-7-1983

(C. RAMESH)

AN ABSTRACT OF THE THESIS OF

C. Ramesh for the Master of Science in Agriculture in
(Name) (Degree)

Plant Physiology submitted on 3-8-1983.
(Department)

Title: "WATER STRESS IMPOSED GROWTH AND YIELD DYNAMICS OF GROUNDNUT (*Arachis hypogaea* L.)"

Major Advisor: Dr. D.V. MADHUSUDANA RAO

A field trial on split plot design was carried out during rabi season of 1982-83 on the College Farm, S.V. Agricultural College, Tirupati to study the effect of four graded moisture stress on growth and yield dynamics in three varieties of groundnut. Moisture levels were considered as main treatments and varieties as sub-treatments for the study.

The observations made revealed that irrigation with ET/PE ratio of 1.0 registered more plant height, number of primary branches, number of leaves, leaf area index, better performance of physiological parameters, earliness to flower, more production of reproductive parts resulting in increased pod yield in all the three cultivars.

Irrigations with ET/PE ratio of 0.6 on the other hand, although resulted in a general reduction in morphological and physiological parameters and yield; the general observation was that reduced soil moisture regime has a moderate adverse impact and influence on the various plant characters and behaved almost similar to that of ET/PE ratio of 1.0.

Severe soil moisture stress treatments resulted in stunted plant growth, lesser number of leaves, delayed flowering, less production of reproductive parts with poor yield potentiality.

Of the three cultivars, Kadiri-2 a semispreading cultivar was found to be tolerant to drought followed by Kadiri-1 a spreading cultivar and TMV-2 a bunch cultivar.

I INTRODUCTION

Much work has been done, mostly of agronomic nature, for optimisation of irrigation water for realising higher yields. Attempts were made to investigate the effects of varied irrigation levels on vegetative growth (Baumann and Norden, 1971; Khan et al., 1972; Singh and Rajendra Prasad, 1980), flowering (Samdaliaris et al., 1978; Williams and Nageswara Rao, 1981) and yield in general (Arant, 1951; Jekie, 1958; Matlock et al., 1961; Seshadri, 1962; Harrison, 1967-69). Number of reports are available on the influence of scheduling of irrigation (Subhash Babu et al., 1977; Buhatende, 1978; Shelke and Khuspe, 1980) and total quantity of irrigation during crop growing season (Mehrotra et al., 1967; Chandra Mohan, 1970; Davidson et al. 1973; Stansell et al., 1976). The effect of various irrigation levels on ultimate yield and its attributes was worked out by Ali et al. (1974), Tamala Reddy (1974) and Williams and Nageswara Rao, (1981).

Although "many agronomists have attempted to increase yield by proper scheduling of irrigation, only final yields are determined, little knowledge can be gained on how yields are achieved. Growth analysis is an effective way of studying growth and development of plants" (Mc Graw, 1979).

While varietal differences in respect of photosynthetic rates could not be observed (Duncan et al., 1978), but large differences in partitioning of assimilates were expected. Carbon assimilation is one of the primary processes. Many factors operate and interact to vary carbon assimilation rate and the total amounts assimilated (Williams and Nageswara Rao, 1981) and their allocation to pods.

The effects of drought, its intensity and phenophase affected were relatively well investigated as indicated above. Studies of decreasing supplies of moisture were made with agronomic objective rather than physiological consequences that become influenced to effect agronomic features like yield and its components. The influence of graded soil moisture regimes on plant growth, development, source and sink size, dry matter production and partitioning needs further understanding. The present experiment is undertaken to assess the drought caused reductions in the photosynthetic structure, thereby in dry matter production and translocation of photosynthates as shown by the partitioning of assimilates and the responses of cultivars of the spanish and virginia group.

II REVIEW OF LITERATURE

Several studies on the effect of drought occuring at various phenophases and the plant responses were related to yield and its components. Similarly, studies on the soil moisture range and the plants internal water status effects caused by varying intensities of irrigation were also made. Crop growth behaviour was studied under normal conditions and very few workers attempted to study the effect of intensity of irrigation on pattern of plant growth and development. A brief resume of work is herewith presented under relavent headings from studies conducted on the influence of intensity of irrigation on plant growth, dry matter production and distribution and yield and related characters.

2.1 GENERAL

Hammond et al. (1978) stated that groundnut plants are drought tolerant because of deep rooting system and flexibility in time of flowering and fruiting. They further noted that yields were not reduced by droughts of short duration unless the seasonal water use was below about 50 cm. Rooting depths were of the order of 200 cm with a density of 1.5 cm per cm^3 in the 0-30 cm zone and 0.1-0.04 cm per cm^3 at greater depths. Tensiometers and neutronmeters showed that water extraction continued during prolonged drought at depths below the shallow irrigated surface soil layer. Pallas et al. (1979) however opined that drought conditions were implicated in causing low yields with some reservation. Under drought conditions, leaf water potential was least during mid season when evaporative demand was greatest. Leaf diffusion resistances, however, increased with lateness and severeness of drought, reflecting leaf age and plant water stress. Much of the plant water stress that developed during drought was relieved the day after irrigation and leaf diffusion resistances also returned to near normal. In groundnut, they felt that when full season irrigation may not be possible because of the demands on the system, scheduling irrigation in the latter part of the season appear next in importance.

2.2 VEGETATIVE GROWTH

2.2.1 Plant height

Decrease in plant height with increase in moisture stress was reported by Tummala Reddy (1974) and Subash Babu (1977) in groundnut and Ali and Alam (1973) and Sankara Reddy (1983) in green gram.

2.2.2 Leaf area expansion

Boyer (1970); Hsiao *et al.* (1970); Acevedo *et al.* (1971) reported that leaf expansion is very sensitive to moisture stress. Decreased leaf area is an inevitable consequence of moisture stress reduces transpiring surface and the demand for water (Turner, 1979). Huck *et al.* (1981) reported that leaf number unaltered with stress whereas leaf area index reduced drastically.

2.2.3 Dry matter production

Baumann and Norden (1971) observed that most peanut cultivars grown commercially in the United States produce excessive vegetative growth under high moisture condition which possibly reduce yield due to photosynthates being utilised for vegetative growth rather than reproductive growth. There was a reduction in vine weight with 70-day drought but not with 35-day drought (Pallas *et al*., 1979) in groundnut.

Khan *et al*. (1972) noted that early and better fruit development was observed in *Arachis hypogaea* L. that completed growth and flowering phases earlier. Prolonged vegetative growth delayed flowering and fruit setting and consequently resulted in poor fruit development because of increased moisture stress in the soil. Singh and Rajendra Prasad (1980) reported that water stress given to pot grown groundnut cultivar resulted in suppression of dry weight extension and expansion.

2.3 TRANSPIRATION

The relative transpiration of a drought resistant variety is generally significantly lower than that of the sensitive variety due to the varietal threshold-potential governing stomatic activity. An earlier and most effective stomatic adjustment makes the drought resistant variety to transpire less (Gautreau, 1970). The reduction in transpiration was mediated through the reduction in transpiring surface in green gram (Ali and Alam, 1973) and in soybean (Huck *et al.*, 1981) or through stomatal closure. The stomatal closure depends on leaf water potential (Turner, 1974a; Turner and Begg, 1975) and stress history of the plant (Mc Cree, 1974; Brown *et al.*, 1976; Thomas *et al.*, 1976); Turner *et al.*, 1978b).

2.4 FLOWERING

Gowda (1977) reported that the moisture stress did not reduce the total number of flowers formed but reduced number of gynophores formed from the first flush of flowering. Flowering stopped when soil moisture content dropped to wilting point but continuation of fruiting depended on the length of the drought (Scandaliaris *et al.*, 1978). Reddy *et al.* (1980) stated that moisture stress early in the season delayed blooming. Williams and Nageswara Rao (1981) noted that a sudden variation in the environment like sudden release of water stress can cause the plant to flower profusely. They opined that water stress may also influence the opening of flowers and initiation may be unaltered.

2.5 PARTITIONING OF PHOTOSYNTHATES

Groundnut exhibit little evidence for improvement of basic photosynthetic processes (Mc Cloud *et al.*, 1980). Selection for improvement of yield were therefore based on photosynthetic partitioning (Duncan *et al.*, 1978). A cultivar with high photosynthetic efficiency would produce more photosynthate with a given amount of radiation and could be normally capable of producing a higher yield (Mc Craw, 1979). However, apportioning of photosynthates in cultivars is a function of translocation to different plant organs. Irrespective of photosynthetic efficiency of a cultivar, partitioning to different organs particularly to pods is a desirable feature as the crop yield is the proportion of total dry matter partitioned to yield component (Gaastra, 1962). This high partitioning of assimilates to pods was valid for high yields in peanut (Mc Cloud et al., 1980).

2.6 VARIETAL VARIATION

Van Dobben (1962) noted that an increase in the yield resulting from the use of varieties may be limited to shift in the distribution of dry matter to more valuable organs without an increment in total yield. Duncan et al. (1978) reported that total dry matter production among cultivars did not change, but only partitioning of photosynthates was changed and it brought a step-wise improvement in yield and in higher yielding cultivars more of daily production of assimilate might be apportioned to the developing fruit and less to vegetative growth than in the low yielding cultivar.

2.7 YIELD

2.7.1 Available soil moisture

Several workers reported that optimum irrigation levels were better for better crop growth (Arant, 1951; Jekio, 1958; Matlock et al., 1961; Seshadri, 1962; Harrison, 1967-69). Adverse effects of moisture stress on pegging was reported by Lee et al. (1972); Khan (1979) and Williams and Nageswara Rao (1981).

Many experiments were conducted to study the effect of soil moisture on crop yields in groundnut. Maximum groundnut yields were obtained in Oklahoma by irrigating when the soil moisture tension in the plant layer zone reached 1 atmosphere (Matlock, 1961). Mantell and Goldin (1964) reported that plants receiving less water obtained progressively more water from greater soil depth. Optimum yields were realised when plants raised under half-field capacity (Mehrotra et al., 1968), to 60 per cent field capacity (Chandra Mohan, 1970), 60 per cent available soil moisture (Ali et al., 1974), 40 per cent soil moisture (Ono et al., 1974) and 0.3-0.4 bars of water tension (Garbett and Rhodes, 1975). Tamala Reddy (1974) observed from his field studies that increase in available soil moisture throughout the crop growth delayed flowering, reduced volume weight, test weight and shelling percentage and increased the pod yield and number of unfilled pods. The number of unfilled pods were more due to continuous flowering because of higher availability of moisture. Keese et al. (1975) noted that growth and fruiting occur primarily during periods when soil moisture is optimum in the effective zone. For maximum potential yield soil depth beyond 60 cm should be wet with water.

2.7.2 Intervals of irrigation

Several workers conducted experiments to fix optimum irrigation interval for realising potential yield in groundnut.

Higher yields were obtained in sandy loams with an irrigation interval of 7 days (Rao and Srinivasulu, 1955; Goldberg et al., 1967) whereas for red loamy soils it was 10 days (Syed Nazeer Peeran et al., 1967) and 7 days (Radder et al., 1969). Reddy et al. (1980) obtained highest yields with high frequency irrigation with same total quantity of water applied. They further noted that at each irrigation frequency, highest yields were obtained when the depth of water applied was equal to that of lost in evapo-transpiration.

2.7.3 Scheduling of irrigation

Several workers have tried to schedule irrigations bas... the ratio between irrigation water and pan evaporation level. In this direction Subramanian et al. (1974) reported that groundnut irrigated at 0.9 and 0.6 ratios between irrigation water and cumulative pan evaporation level (IW/CPE) at various phenophases gave higher yields. Similarly Subash Babu et al. (1977) reported that pod yields of groundnut was highest when irrigations were scheduled once in fifteen days during pegging when the ratio between the irrigation water applied to the cumulative evaporation from open pan evaporation (ET/PE) was 1.0 during pegging to pod formation and once in ten days during pod formation to maturity.

Groundnut which sown in February and given irrigations scheduled at 75, 100 and 125 or 150 cumulative pan evaporation (CPE) gave the highest pod yields with irrigation scheduled at

75 mm of CPE (Dahatonde, 1978). Birajdar and Ingle (1979) obtained higher yields by scheduling irrigation corresponding to 100 mm of CPE whereas Shelke and Khuspe (1980) obtained significant increase in yield with irrigation scheduled after 40 and 80 mm over 120 mm CPE. Khan and Datta (1982) obtained maximum yields at 0.75 IW/CPE ratio.

2.7.4 <u>Quantum of irrigation</u>

Some of the irrigation experiments in groundnut were directed to elucidate information on quantity of irrigation water required for the successful raising of the crop. Mehrotra *et al*. (1967) reported that highest pod yield was recorded when irrigations were given to a depth of 100 mm compared to lower depths of irrigation. The optimum water requirement for TMV-2 groundnut grown in sandy loam soil was 60.6 cm (Chandra Mohan, 1970). Similarly Davidson *et al*. (1975) observed that 50.8 to 76.2 mm of water was required for realising higher yields.

Three groundnut cultivars were maintained at soil water level ranging from moderately wet to very dry in irrigated plots with rainfall-control shelters. Pod yield and quality were significantly reduced in treatments receiving less than 30 cm water during the growing season. Yield and quality tended to improve as irrigation improved to 40 and 60 cm. When soil moisture tension in the surface of 30 cm reached 15 bar before irrigation and the yields were low. Apparent plant water use from profile depths less than 60 cm depth was observed at about 75 days after sowing. Water use by Florigiant was greater than by Florunner and the early maturing Tifspan reached its greatest water use earlier than the other cultivars (Stansell *et al.*, 1976).

III MATERIALS AND METHODS

A field experiment was conducted on sandy loam soils of S.V. Agricultural College Farm, Tirupati during rabi 1982-83 to study the effect of graded moisture stress on growth and yield dynamics.

3.1 WEATHER CONDITIONS DURING THE CROP PERIOD

The S.V. Agricultural College Farm, Tirupati is situated at an altitude of 182.9 m above mean sea level and 13° North latitude and 79° East longitude. The weather data for rabi 1982-83 is presented in Table 1. Total rain received during the cropperiod was 13.6 mm.

3.2 EXPERIMENTAL DESIGN AND LAYOUT

The experiment was laid out in split-plot design with irrigation treatments as main plots and varieties as sub-plots (Fig. 1).

3.3 DETAILS OF TREATMENTS

3.3.1 Main plots

Irrigation at 1.0, 0.6, 0.2 and 0.0 ET/PE ratios.

T_1 = Control. Irrigation with 5 cm of water whenever cumulative pan evaporation reaches 5 cm (ET/PE = 1.0)

T_2 = Irrigation with 3 cm of water whenever cumulative pan evaporation reaches 5 cm (ET/PE = 0.6)

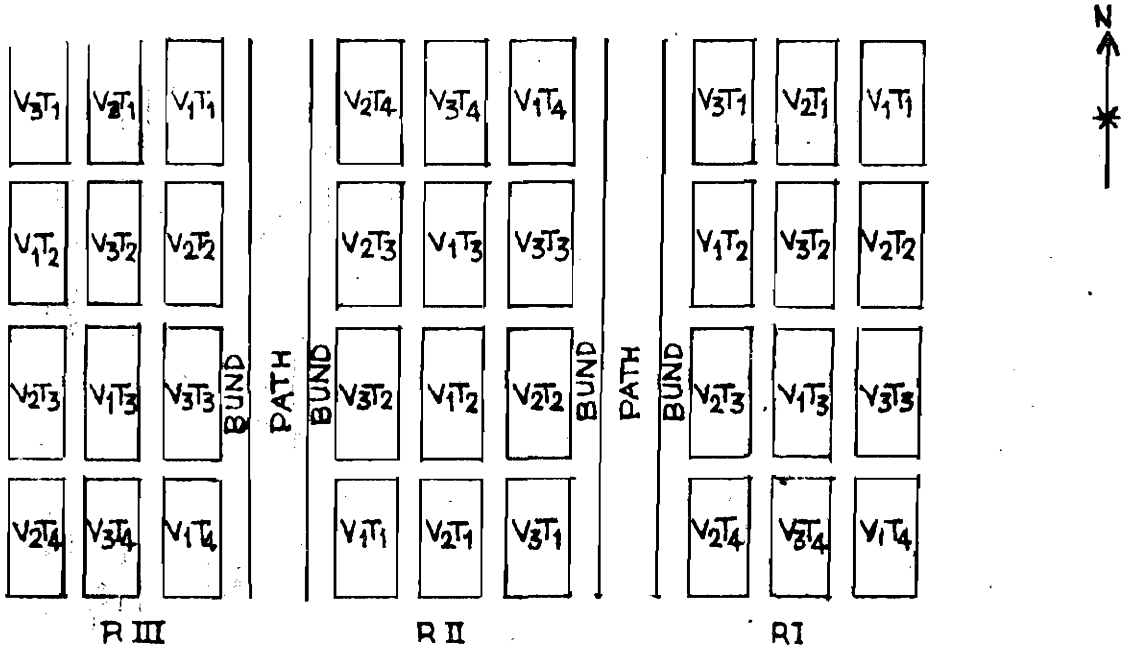
T_3 = Irrigation with 1 cm of water whenever cumulative pan evaporation reaches 5 cm (ET/PE = 0.2)

T_4 = Continuous stress (no irrigation after emergence of seedlings) (ET/PE = 0)

TABLE 1: Weekly meteorological data during crop period (23-12-1982 to 6-5-1983)

Standard week	Days of the DATE (IN WEEK) week and month	Rain (mm)	Mean temperature (°C) Maximum	Mean temperature (°C) Minimum	Mean relative humidity (%) 7-10 A.M	Mean relative humidity (%) 2-10 P.M	Sunshine hours per day	Evaporation (mm) per day (U.S.W.B. Class I open pan)
51	17-23 December	–	29.6	16.8	79	45	9.2	5.9
52	24-31 "	–	29.4	14.9	83	40	8.8	4.8
1	1-7 January	–	29.8	14.6	79	35	9.2	6.3
2	8-14 "	–	29.6	12.3	81	34	9.9	5.5
3	15-21 "	–	29.6	14.4	81	38	9.1	6.5
4	22-28 "	–	30.0	15.5	84	35	9.4	6.5
5	29-4 February	–	34.0	17.9	68	29	9.9	6.7
6	5-11 "	2.2	32.6	22.0	75	45	7.7	6.0
7	12-18 "	–	32.8	18.3	78	32	9.4	7.4
8	19-25 "	–	36.3	21.5	77	27	10.0	8.0
9	26-4 March	–	36.3	19.7	68	24	10.1	9.2
10	5-11 "	–	34.9	19.8	70	27	10.2	8.6
11	12-18 "	–	39.1	21.4	54	16	10.1	10.6
12	19-25 "	10.2	38.4	23.2	72	32	9.0	8.5
13	26-1 April	–	38.5	21.2	70	21	10.6	10.0
14	2-8 "	–	38.6	21.0	46	19	10.7	10.4
15	9-15 "	1.2	40.6	25.4	67	28	10.6	10.1
16	16-22 "	–	38.7	23.2	66	26	10.2	9.7
17	23-29 "	–	39.4	25.6	61	29	9.4	10.4
18	30-6 May	–	41.2	26.4	59	20	10.6	12.5

FIG. 1 FIELD LAYOUT PLAN



DESIGN : SPLIT PLOT

REPLICATIONS : 3

GROSS PLOT SIZE : 3 M X 2 M

NET PLOT SIZE : 2.1 M X 1.6 M

VARIETIES : 3

V1 : TMV 2

V2 : KADIRI -1

V3 : KADIRI -2

TREATMENTS : 4

T1 : CONTROL . IRRIGATION WITH 5CM OF WATER WHENEVER CUMULATIVE PAN EVAPORATION REACHES 5 CM

T2 : IRRIGATION WITH 3CM OF WATER WHENEVER CUMULATIVE PAN EVAPORATION REACHES 5CM

T3 : IRRIGATION WITH 1CM OF WATER WHENEVER CUMULATIVE PAN EVAPORATION REACHES 5CM

T4 : CONTINUOUS STRESS (NO IRRIGATION AFTER EMERGENCE OF SEEDLINGS)

3.3.2 Varieties (Sub-plots)

V_1 = TMV-2 (Spanish bunch)

V_2 = Kadiri-1 (Virginia runner)

V_3 = Kadiri-2 (Virginia bunch)

3.4 PLOT SIZE

Gross plot size = 3.0 x 2.0 m = 6 sq. m.

Net plot size = 2.10 x 1.60 m = 3.36 sq. m.

Replications = Three

The cumulative pan evaporation readings were taken from U.S.W.B. Class I Open Pan Evaporimeter and irrigations were scheduled based on their ratios. A measured quantity of water was applied to each plot on each occasion.

The quantity of water applied at each irrigation was calculated by using the formula

Total quantity of water (m^3) = Plot size (m^2) x depth of water (m)

3.5 CULTIVATION DETAILS

The experimental field was prepared for sowing by working twice with tractor drawn cultivator and then blade harrow was worked. The land was perfectly levelled with wooden plank. The experiment was laid out according to the layout plan.

3.5.1 Fertilizers

The sources of fertilizers for N, P and K were urea (46% N), single superphosphate (16.88% P) and muriate of potash (49.8% K) respectively. Nitrogen, phosphorus and potash were applied @ 30 kg N, 10 kg P_2O_5 and 25 kg K_2O per hectare to all plots. Entire dose of phosphorus and potash and half the treatmental dose of nitrogen were uniformly broadcasted before sowing and incorporated into the soil. Remaining half the dose of nitrogen was top dressed by band placement 30 days after sowing.

3.5.2 Seeds and sowing

Clean and bold seeds of groundnut were selected and treated with captan (@ 3 g/kg kernels) and were sown on 23-12-1982 by dibbling in open furrows made with hand hoe to a depth of 3-4 cm with a spacing of 30 x 10 cm for bunch and 30 x 15 cm for runner. Gap filling was done eight days after sowing (DAS).

3.5.3 After care

The field was irrigated immediately after sowing for better germination. Another life irrigation was given five days after sowing, subsequent irrigations were given as per the schedule. Weeding was done twice viz., 20 days and 40 days after sowing. Tikka leaf spot was noticed in TMV-2 variety but the damage was negligible due to late incidence (82 days after sowing). Bavistin (0.2%) was sprayed to all plots after noticing the incidence of Tikka. In general, the crop was healthy.

3.6 HARVESTING

The crop was considered mature when 75 per cent of the pods showed a blackish tinge on the inner side of the shell. The border rows were harvested first and bulked seperately. The plants in the net plot were hand pulled seperately and pods were stripped. Pods and haulms were sun dried properly and the yields were recorded (kg/ha).

3.7 OBSERVATIONS RECORDED

For recording pre-harvest observations, three plants in the bulk plot were randomly selected. The data of observations recorded on three plants were averaged and expressed as mean values per plant.

3.7.1 Preharvest observations

The data on the following characters were collected at 10-day intervals from sowing till harvest from randomly selected three plants from each treatment of every replication.

3.7.1.1 Plant height (cm):- Plant height from the ground level to the tip of the main stem was measured.

3.7.1.2 Number of primary branches:- The number of primary branches per plant was counted.

3.7.1.3 Number of leaves:- The number of leaves per plant was counted.

3. 3.7.1.4 Leaf area index (LAI):- The LI-COR Model LI-3000 Portable area meter with the transparent belt conveyor accessary (Model LI-3050 A) utilising an electronic digital display was used for measuring leaf area. The area was integrated and displayed in cm^2 as the leaves were passed through the scanning head. Leaf area index was calculated by dividing the total leaf area by the corresponding ground area as suggested by Watson (1947).

$$\text{Leaf Area Index (LAI)} = \frac{\text{Total leaf area}}{\text{Ground area}}$$

3.7.1.5 Flowers:- The flowers opened on randomly selected and tagged plants were counted daily in the morning hours.

3.7.1.6 Number of pegs:- The number of pegs per each of the three plants were counted and averaged.

3.7.1.7 Number of pods:- The number of pods per each of the three samples were counted and averaged.

3.7.1.8 Dry matter accumulation per plant:- Destructive sampling of three plants at 10 days interval was done till harvest. The plants were lifted with root system upto maximum possible depth including laterals with a monolith, root portions seperated and the shoots were apportioned into leaf, stem, petiole, pegs, pod wall and kernel, dried in hot air oven at 80°C till a constant weight was obtained. Then the weight of dry matter (g) was recorded.

3.7.1.9 <u>Transpiration</u>:- Transpiration was calculated by detached leaf method. A leaf at the base of the petiole was detached and weighed. After weighing, the leaf was taken back to the place where it was detached and kept in intact position for 3 minutes. After 3 minutes it was again weighed and leaf area of the same leaf was taken with leaf area meter. During the 3 minutes, leaf transpire water and this was reflected by loss of weight of the leaf. Based on this, transpiration was calculated in mg/dm^2/1 minute.

3.7.1.10 <u>Soil moisture</u>:- Soil samples were taken at three depths, 0-25 cm, 25-50 cm and 50-75 cm depth, with a soil auger from each treatment before and after irrigation. Total quantity of irrigation water applied during the crop period to TMV-2 was 710, 430, 150 mm and Kadiri-1 and Kadiri-2 received 810, 490, 170 mm in T_1, T_2 and T_3 respectively. Soil moisture percentage was calculated by using the formula

$$\text{Soil moisture percentage} = \frac{\text{Fresh weight of soil - dry weight of soil}}{\text{Dry weight of soil}} \times 100$$

3.7.2 <u>Post-harvest observations</u>

The data on post-harvest observations were recorded from five randomly selected plants from each plot of every replication.

3.7.2.1 <u>Number of total pods per plant</u>:- All the pods per plant were counted and recorded.

3.7.2.2 Number of filled and unfilled pods per plant:- The number of filled and unfilled pods were counted, averaged and expressed per plant.

3.7.2.3 100-kernel weight (g):- From the shelled out samples, for recording shelling percentage, 100-kernels were selected at random and weighed.

3.7.2.4 Shelling percentage:- The ratio between kernel to pod weight was worked out for each treatment and expressed as percentage.

3.7.2.5 Pod yield (kg/ha):- After drying the pods from net plot, yield per plot was recorded by weighing the pods. Based on plot yield, hectare yield was worked out for each treatment and expressed in kg/ha.

3.7.2.6 Haulm yield (kg/ha):- After attaining a constant weight the haulms of the net plot were weighed and expressed in kg/plot and then calculated per hectare.

3.7.2.7 Harvest index:- It is computed to find out the efficiency of treatments in utilising the photosynthates for pod production. Harvest index is calculated by adopting the following formula (Donald, 1962).

$$\text{Harvest index} = \frac{\text{Pod yield (kg/ha)}}{\text{Total dry matter (kg/ha)}}$$

3.8 STATISTICAL ANALYSIS

The data were analysed by the method of analysis of variance outlined by Panse and Sukhatme (1967). Significance was tested by 'F' value at 5% level of probability. Critical differences were worked out for the effects which were significant. Analysis was not done for computed data.

IV RESULTS

In the present study a field trial was conducted to assess the effect of graded moisture stress on growth, development and yield in three groundnut cultivars.

The data obtained on various morphological, physiological and yield and its contributing characteristics were subjected to statistical analysis. The mean values of three replications of individual treatments were tabulated. Data collected at 10 day intervals on certain morphological and physiological characters were represented in graphs.

In the following paragraphs data on different characteristics to bring about treatmental evaluation has been narrated.

4.1 GROWTH ATTRIBUTES

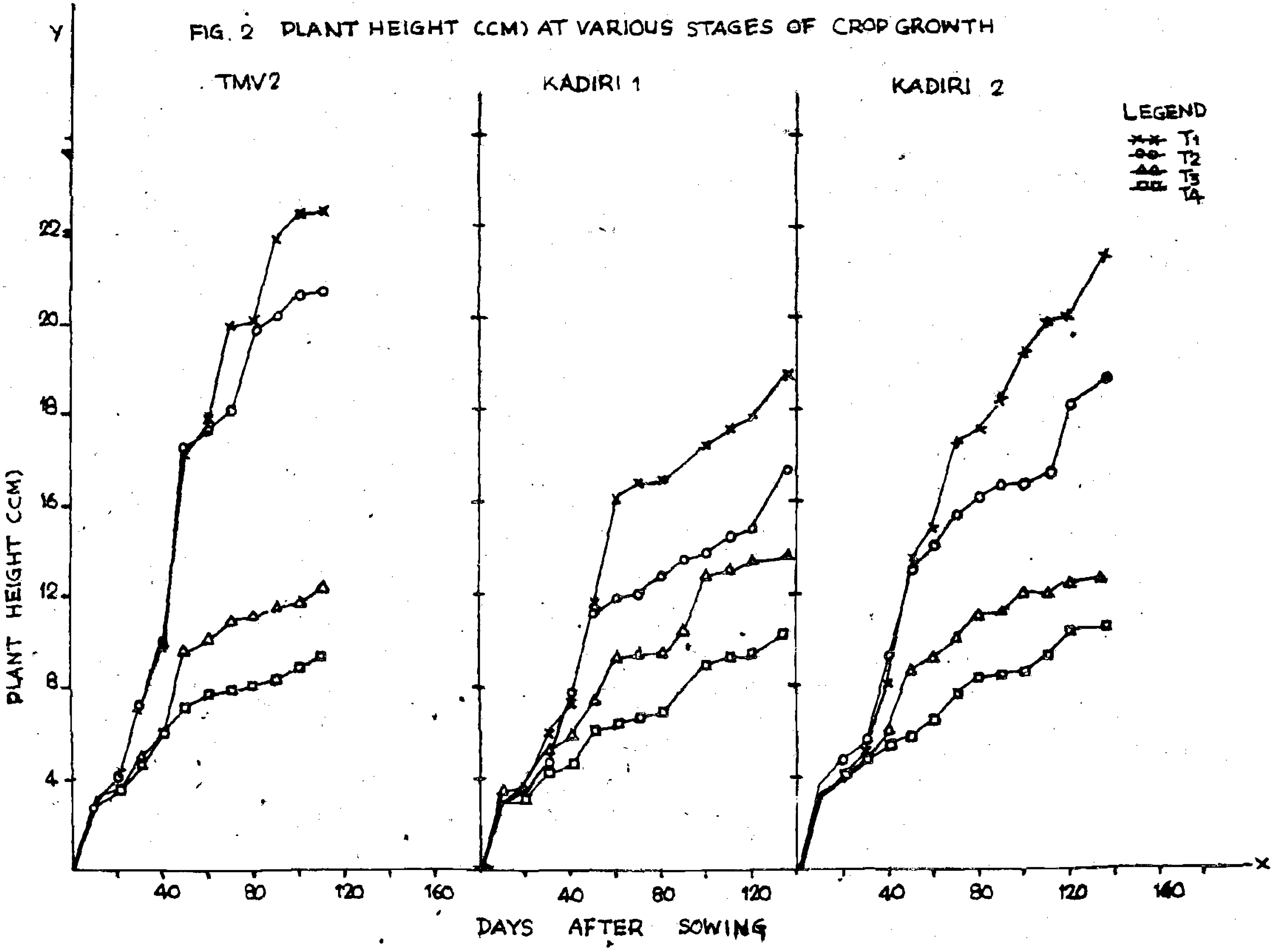
4.1.1 Plant height

The data on plant height (Table 2 and Fig. 2) in general showed a steady increase of 2-3 cm for every ten day period of observation till 40th day after sowing. The growth during this period was found to be slow in all the three varieties. This stage thus might indicate lag phase for the crop. From a critical examination of the data recorded between 40th and 50th day, it is quite discernable that the rate of growth was exponential with an increase of about 12 cm in TMV-2, 7 cm in Kadiri-2 and such log phase was observed between 50th and 60th day with an increase of 5 cm in the case of Kadiri-1.

TABLE 2: Plant height (cm) at various growth stages

Treatment	Days after sowing												
	10	20	30	40	50	60	70	80	90	100	110	120	136
V_1 T_1	2.75	4.00	7.07	9.73	17.84	19.61	23.76	23.85	27.40	28.47	28.57		
V_1 T_2	2.99	4.12	7.20	9.91	18.37	19.17	20.41	23.63	24.15	25.01	25.32		
V_1 T_3	2.57	3.67	5.54	6.14	9.63	10.58	10.80	11.33	11.40	11.59	13.09		
V_1 T_4	2.77	3.50	4.62	4.66	6.04	7.15	7.59	7.86	7.93	8.32	9.32		
V_2 T_1	2.67	3.94	6.03	7.31	11.64	16.18	16.81	16.92	18.41	19.10	19.71	19.94	21.82
V_2 T_2	2.97	3.63	4.71	7.80	11.20	11.82	12.11	12.82	13.49	13.93	14.52	14.89	17.11
V_2 T_3	3.52	3.60	5.19	5.81	7.37	9.19	9.33	9.53	10.49	11.80	12.10	12.55	12.61
V_2 T_4	2.95	3.07	4.24	4.58	6.02	6.30	6.58	6.75	8.99	9.25	9.35	10.10	10.23
V_3 T_1	3.22	4.15	5.08	8.00	15.51	16.84	18.60	19.11	20.39	22.49	23.87	25.00	26.74
V_3 T_2	3.40	4.68	5.58	9.28	13.08	14.14	15.43	16.14	16.64	16.71	17.24	20.28	21.99
V_3 T_3	3.07	3.81	4.69	6.05	8.71	9.29	10.08	11.01	11.26	11.96	12.10	12.51	12.58
V_3 T_4	3.01	4.00	4.59	5.38	5.69	6.36	7.69	8.22	8.52	8.72	9.30	10.41	10.55
C.D. at 5% for													
Treatments	0.13	0.16	0.21	0.25	0.53	0.57	0.38	0.33	0.17	0.29	0.41	0.28	0.38
Varieties	0.21	0.22	0.24	0.28	0.37	0.43	0.34	0.32	0.29	0.24	0.22	0.29	0.26
Interactions	0.42	0.44	0.48	0.55	0.74	0.86	0.68	0.64	0.58	0.49	0.44	0.57	0.52

FIG. 2 PLANT HEIGHT (CM) AT VARIOUS STAGES OF CROP GROWTH



The increase in plant height from 50th day in the case of TMV-2 and Kadiri-2 was slow, but continuous and consistent with an increase of about 1-4 cm in TMV-2, for each ten day observation and such increase in plant growth was evident even in the case of Kadiri-2 also with a marginal increase of about 1-2 cm per subsequent ten day period observation whereas such increase in plant height was slow and consistent in the case of Kadiri-1 from 60th day onwards with an increase of 0.5-2.0 cm per ten days till the last period of sampling. Maximum height (28.5 cm) was observed in TMV-2, a bunch groundnut, followed by Kadiri-2 (26.7 cm), a semispreading and the plant height values of Kadiri-1, a spreading type, was ~~in between these two values~~ (21.8 cm) at last occasion of sampling.

It is also interesting to note that same growth pattern was observed with all other treatments, however, maximum growth was less with increase in stress. There was decrease in plant height with decrease in moisture regime. A critical examination of the data at the final sampling indicated that maximum values were recorded with T_1 treatment by all the cultivars and final plant height was gradually decreased with decreasing moisture regimes included in the experiment. The differences between the values of T_1 and T_2 were marginal in the case of TMV-2 and T_3 and T_4 suffered most which recorded half of the values of well irrigated treatment (T_1). In the next two varieties viz., Kadiri-1 and Kadiri-2, the decrease in plant height with reduced water supply was gradual, consistent and uniform. The differences between various treatments in all the three varieties arose primarily during the lag phase of the plant growth.

The differences between main and sub-treatments and their interactions were statistically significant.

4.1.2 Number of primary branches

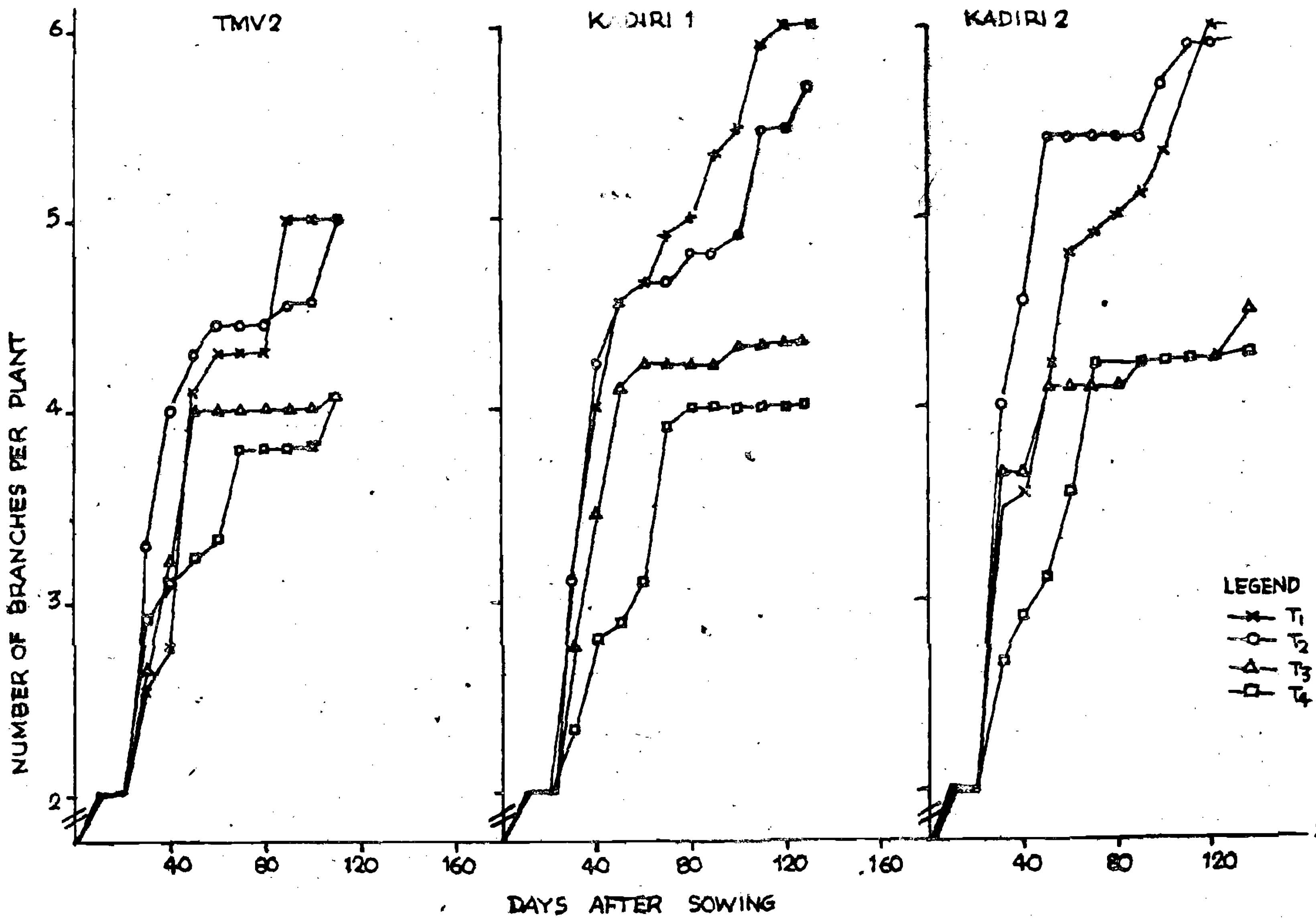
The data on mean number of primary branches per plant (Table 3 and Fig. 3) indicated that two primary branches per plant were added by 10th day and two more were added by 50th day in the case of TMV-2, 4.6 in the case of Kadiri-1 and 4.8 in the case of Kadiri-2 by 60th day under well irrigated conditions. There was gradual increase in the production of number of primary branches with time and maximum number was reached by about 20-30 days before harvest in all the varieties and treatments. Data recorded at harvest indicated that about five branches were produced by TMV-2 and six by Kadiri-1 and Kadiri-2 under well irrigated conditions. The production of number of primary branches gradually declined at lower soil moisture regimes. Such reduction in the number of primary branches was observed right from 30th day onwards in the case of last two moisture stress regimes whereas the values of T_1 and T_2 treatments in all the three varieties tend to be closer right from the beginning to the end of the crop growth. Likewise, the differences between T_3 and T_4 were not marked and they were tend to be closer.

TABLE 3: Number of primary branches per plant

Treatments	Days after sowing												
	10	20	30	40	50	60	70	80	90	100	110	120	136
V_1 T_1	2.0	2.0	2.56	2.78	4.11	4.33	4.33	4.33	5.00	5.00	5.00		
V_1 T_2	2.0	2.0	3.33	4.00	4.33	4.44	4.44	4.44	4.55	4.55	5.00		
V_1 T_3	2.0	2.0	3.22	3.22	4.00	4.00	4.00	4.00	4.00	4.00	4.07		
V_1 T_4	2.0	2.0	2.89	3.11	3.22	3.33	3.78	3.78	3.78	3.78	4.07		
V_2 T_1	2.0	2.0	3.11	4.00	4.56	4.67	4.89	5.00	5.33	5.44	5.89	6.00	6.00
V_2 T_2	2.0	2.0	3.11	4.22	4.56	4.67	4.67	4.78	4.78	4.89	5.45	5.45	5.67
V_2 T_3	2.0	2.0	3.00	3.44	4.11	4.22	4.22	4.22	4.22	4.34	4.34	4.34	4.34
V_2 T_4	2.0	2.0	2.44	2.78	3.00	3.11	3.89	4.00	4.00	4.00	4.00	4.00	4.00
V_3 T_1	2.0	2.0	3.44	3.55	4.22	4.79	4.89	5.00	5.11	5.34	5.67	6.00	6.00
V_3 T_2	2.0	2.0	4.00	4.55	5.67	5.68	5.67	5.67	5.67	5.78	5.89	5.89	5.93
V_3 T_3	2.0	2.0	3.67	3.67	4.11	4.11	4.11	4.11	4.22	4.22	4.22	4.22	4.47
V_3 T_4	2.0	2.0	2.67	2.89	3.11	3.56	4.22	4.22	4.22	4.22	4.22	4.22	4.27
C.D. at 5% for													
Treatments			0.35	0.37	0.18	0.17	0.45	0.26	0.31	0.24	0.22	0.21	0.29
Varieties	N.S.	N.S.	0.26	0.24	0.16	0.21	0.15	0.21	0.19	0.17	0.12	0.16	0.21
Interactions			0.52	0.49	0.33	0.42	0.29	0.42	0.38	0.35	0.23	0.32	0.41

N.S = Non-significant

FIG. 3 NUMBER OF PRIMARY BRANCHES AT VARIOUS STAGES OF CROP GROWTH



The differences between main and sub-treatments and their interactions were statistically significant at all stages of crop growth except at 10th and 20th day after sowing.

4.1.3 Number of leaves per plant

Maximum number of leaves of about 160 was produced by Kadiri-2 at 120th day followed by Kadiri-1 (153) at 100 days and TMV-2 (46) at 110 days (Table 4 and Fig. 4). There was a gradual increase in number of leaves in TMV-2 till harvest as no leaf senescence had set in by then whereas, the other two varieties had maximum number of leaves at 100 DAS in Kadiri-1 and between 80 to 120 days in Kadiri-2 after which older leaves started showing symptoms of senescence.

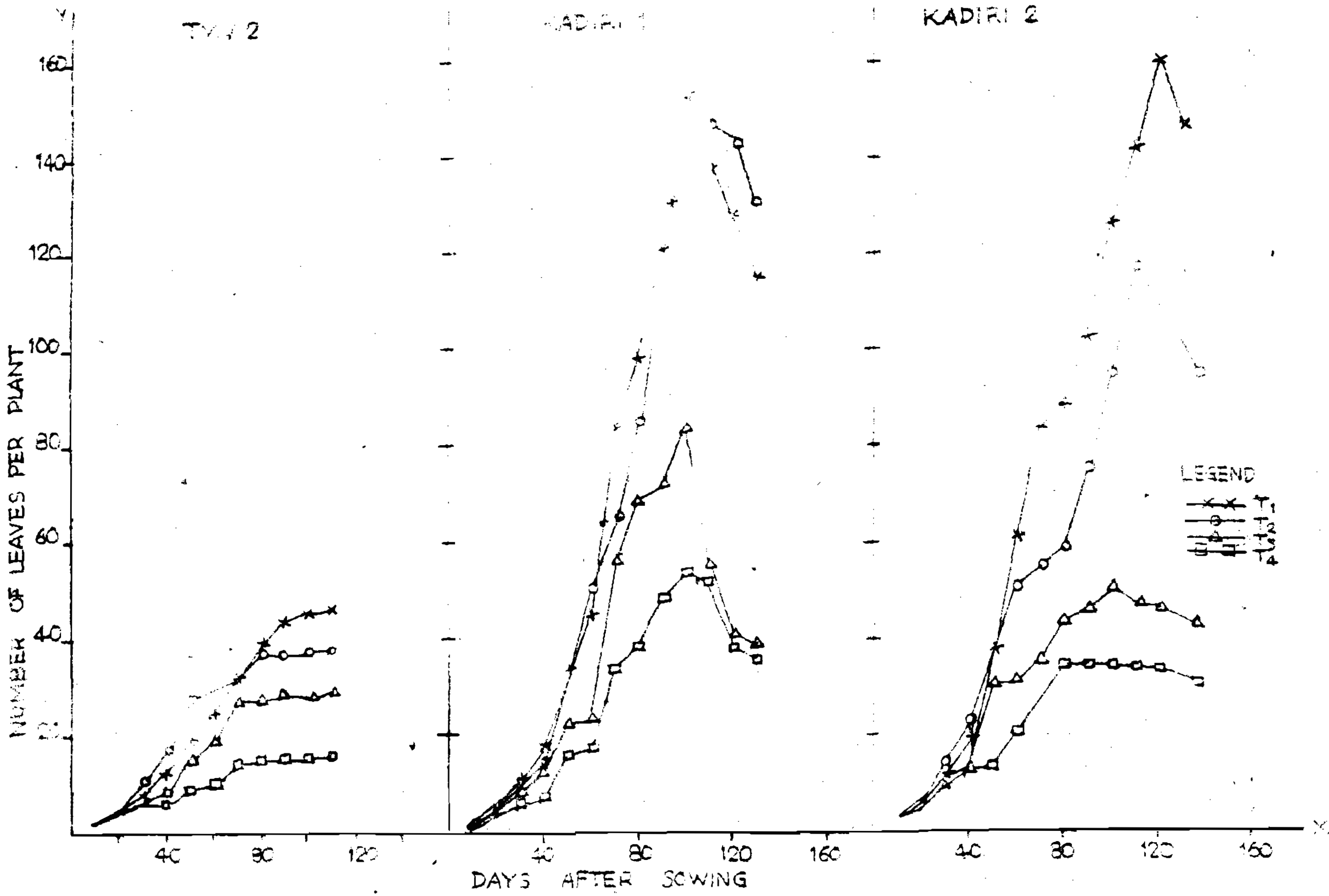
In TMV-2 maximum leaf number was reached at 110th day irrespective of irrigation treatments given. The effect of various soil moisture regimes did not result in variation in respect of number of leaves upto 20 days and there after difference between various treatments have surfaced out and such differences slowly magnified with crop growth; the fall in leaf number was almost proportional to the quantum of irrigation applied in respective treatments.

In Kadiri-1 and Kadiri-2 the influence of treatments on leaf number was evident right from 20 days after sowing and there was gradual decline in leaf production with decreasing

TABLE 4: Number of leaves per plant

Treatment	Days after sowing												
	10	20	30	40	50	60	70	80	90	100	110	120	
$V_1 T_1$	2.22	4.44	7.89	12.44	23.00	24.78	32.44	39.67	43.55	45.44	46.80		
$V_1 T_2$	3.00	4.89	10.00	17.11	28.22	30.77	32.44	37.78	37.55	37.83	37.94		
$V_1 T_3$	2.78	4.11	7.89	8.89	15.56	19.94	27.78	28.11	28.67	28.94	29.12		
$V_1 T_4$	3.00	4.00	6.22	6.33	8.78	9.44	14.67	15.22	15.56	15.78	16.20		
$V_2 T_1$	3.00	6.22	10.78	17.44	33.11	45.44	84.78	108.11	131.22	153.33	137.66	127.78	115.6
$V_2 T_2$	3.00	5.89	9.55	16.11	34.00	51.44	66.33	80.78	121.78	166.89	146.67	143.78	131.6
$V_2 T_3$	2.89	5.00	8.55	13.67	22.67	23.55	37.00	68.78	71.55	83.11	55.11	41.78	39.2
$V_2 T_4$	2.89	3.67	5.89	6.33	16.00	16.89	34.22	38.55	49.56	63.33	52.22	37.33	35.7
$V_3 T_1$	3.00	5.11	10.55	19.89	37.22	61.55	84.11	88.22	103.33	132.78	142.22	160.11	145.6
$V_3 T_2$	3.00	6.11	13.89	22.56	36.33	50.07	55.00	58.89	75.00	95.00	116.67	108.22	94.8
$V_3 T_3$	2.89	5.33	10.67	12.22	30.89	31.44	35.56	43.55	45.89	50.00	47.22	46.11	42.6
$V_3 T_4$	3.11	4.55	9.11	12.00	13.33	20.44	41.89	34.11	34.00	34.00	33.78	33.11	30.2
C.D. at 5% for													
Treatments	0.22	0.29	0.16	0.41	0.19	0.86	0.91	3.18	0.79	0.89	1.29	2.07	1.79
Varieties	0.13	0.18	0.26	0.29	0.54	0.35	0.81	1.47	0.58	0.98	0.83	1.23	0.78
Interactions	0.25	0.37	0.51	0.39	1.08	0.69	1.62	2.94	1.16	1.97	1.66	2.46	1.55

FIG. 4 NUMBER OF LEAVES PE[illegible] [illegible]ANT AT [illegible] [illegible]US STAGES OF CROP GROWTH



the quantity of water. The first two irrigation schedules behaved similarly and were far superior to the last two irrigation treatments in the case of Kadiri-1. In otherwords, the leaf number drastically fell with T_3 onwards which recorded half of the leaf number of T_1.

In the case of Kadiri-2 maximum leaf number was attained by 120th day in the case of T_1, 110th day with T_2, 100th day with T_3 and 70th day with T_4.

All the three varieties suffered equally in leaf production with stress. The leaf production was gradually decreased with stress in the case of TMV-2 and Kadiri-2 whereas there was no reduction in leaf production with first two treatments of irrigation but the production of leaves declined drastically when the applied water was reduced to 0.2 of ET/PE ratio in the case of Kadiri-1. Leaf fall was observed after the plants attaining maximum leaf number in the case of spreading and semispreading cultivars in all the treatments.

The differences between main and sub-treatments and their interactions were statistically significant.

4.1.4 <u>Number of flowers</u>

Flowers started appearing by 34th-35th day in TMV-2 and Kadiri-1 and Kadiri-2 took about 40 days after sowing for flowering under normal irrigated conditions (Table 5 and Fig. 5.1, 5.2 and 5.3). There was a gradual decline in number of flowers

TABLE 5: Daily flower count per plant

Treatment	January 1983							February 1983																		
	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
	Days after sowing																									
	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59
V_1T_1		0.13	0.17	0.20	0.87	0.83	0.80	1.27	2.07	1.40	1.40	2.13	1.37	1.67	3.40	3.13	2.53	1.40	3.06	3.50	3.00	2.67	0.73	0.40	0.13	0.47
V_1T_2	0.13	0.17	0.23	0.47	0.73	0.67	0.53	0.87	1.30	1.27	1.67	1.30	1.70	1.60	1.73	1.30	1.27	1.30	2.40	2.33	2.00	1.73	1.07	0.67	0.30	0.40
V_1T_3				0.20	0.60	0.73	0.30	0.30	0.93	1.13	1.13	0.30	0.77	0.73	1.53	1.06	0.40	3.00	0.93	0.60	0.53	0.47	0.53	0.30	0.53	0.67
V_1T_4							0.20	0.33	0.53	0.27	0.47	0.20	0.07	0.53	0.73	0.33	0.07	0	0.40	0.07	0.07	0.07	0.07	0.07	0	0.07
V_2T_1	0.13	0.33	0.33	0.33	0.40	0.53	0.13	0.40	0.60	0.67	0.60	0.33	0.87	0.73	1.07	0.37	0.33	0.40	2.30	1.47	2.07	2.33	2.27	2.30	2.30	2.47
V_2T_2							0.13	0	0.07	0.47	0.33	0.40	0.50	0.53	1.20	0.73	0.47	0.67	1.27	1.27	1.30	11.4	1.07	1.47	1.73	1.93
V_2T_3							0.07	0	0.07	0	0.33	0.73	0.53	0.47	0.60	0.37	0	0.27	0.80	1.07	1.27	1.13	2.13	1.30	1.13	1.40
V_2T_4									0.07	0	0.13	0.27	0.27	0.27	0.33	0.33	0	0.13	0.60	0.40	0.40	0.40	0.80	0.53	0.47	0.53
V_3T_1							0.30	0.13	0.60	0.33	0.93	1.07	1.33	1.67	1.20	1.33	1.13	0.73	2.40	2.67	2.33	1.73	2.47	1.93	2.33	2.93
V_3T_2							0.07	0.07	0.27	0.60	0.47	0.93	0.83	0.67	1.27	1.33	0.20	0.37	1.53	1.33	1.13	1.67	1.67	1.20	0.73	1.53
V_3T_3							0.13	0	0.07	0.33	0.47	0.40	0.80	1.20	0.73	0.53	0	0.60	1.27	0.60	0.83	1.67	1.13	1.33	0.30	1.40
V_3T_4									0.07	0.07	0	0.07	0.07	0.13	0.07	0.27	0	0	0.73	0.07	0.27	0.26	0.13	0.20	0.07	0.13

	February 1983								March 1983				
	20	21	22	23	24	25	26	27	28	1	2	3	4
	60	61	62	63	64	65	66	67	68	69	70	71	72
V_1T_1	0.63	0.87	0.47	0.13	0.07	0	0	0	0	0	0.13	0	0
V_1T_2	2.33	2.00	0.47	0.87	0.60	0	0.13	0.27	0.33	0.80	0.27	0.20	0
V_1T_3	0.55	0.35	0.53	0.40	0.33	0	0.33	0.53	0.67	0.26	0.07	0.53	0.13
V_1T_4	0.07	0.07	0.07	0.13	0	0.07	0.20	0.33	0.40	0.27	0.07	0	0.13
V_2T_1	2.67	3.80	2.40	5.47	4.67	0	2.80	2.33	1.33	1.73	4.40	2.40	1.40
V_2T_2	2.53	3.13	1.73	4.27	2.53	0	1.47	1.67	2.07	2.13	2.87	1.40	1.00
V_2T_3	1.54	1.33	1.33	1.73	2.60	0	1.93	2.67	3.53	1.20	1.07	1.60	1.33
V_2T_4	0.67	1.13	0.40	0.93	1.33	0.40	0.33	1.13	1.56	0.47	1.13	1.33	1.28
V_3T_1	3.33	3.67	2.27	4.80	2.87	0	1.20	1.67	2.33	3.67	2.33	1.33	0.08
V_3T_2	1.87	2.33	0.80	2.33	1.47	0	1.13	1.56	1.86	2.67	1.40	1.00	0
V_3T_3	1.53	0.87	0.73	2.00	1.27	0	0.67	0.83	1.20	0.40	0.73	1.33	0.30
V_3T_4	0.23	0.27	0	0.20	0	0	0	0	0.23	0.17	0.07	0	0

	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	73	74	75	76	77	78	79	80	81	82	83	84	85	86
V_1T_1	0	0.17	0.33	0.37	0.07									
V_1T_2	0.07	0.27	0.08	0.33	0	0.47								
V_1T_3	0.13	0.27	0.53	0.50	0.43	0.27	0.20	0.07	0	0	0.07	0.33	0.67	0.04
V_1T_4	0	0.10	0.13	0.13	0.13	0.07	0.13	0.07	0	0	0.07	0.07	0.20	0.57
V_2T_1	1.20	3.43	6.87	5.33	4.80	2.87	0.80	0.13	0.07	0	0	0	7.67	1.57
V_2T_2	1.67	2.43	5.40	5.13	2.80	2.60	1.55	1.67	1.33	0	0.07	0.33	3.07	1.37
V_2T_3	1.13	2.67	5.20	5.53	1.47	2.33	1.47	1.67	1.33	1.00	0.90	0.80	2.40	1.33
V_2T_4	1.67	1.73	1.80	1.83	1.87	1.47	1.53	1.53	1.51	1.55	0.67	0.40	0.60	0.67
V_3T_1	0.07	1.33	5.07	4.33	1.33	0.80	0.07	0	0	0	0	0	1.00	0.50
V_3T_2	0.67	5.33	7.80	1.33	0.80	0.60	0	0	0	0	0	0	3.73	1.60
V_3T_3	0.73	1.33	1.47	1.00	0.73	1.27	1.27	0.67	0.33	0.07	0.07	1.00	2.13	0.93
V_3T_4	0	0.07	0.07	0.07	0	0.20	0	0	0	0	0.33	0.73	0.33	1.47

Treatment	March 1983 19	20	21	22	23	24	25	26	27	28	29	30	31	April 1983 1	2	3	4	5	6	7	8	9	10	11	12	13	14
Days after sowing	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113
V_1T_1	0																										
V_1T_2	0																										
V_1T_3	0	0	0	0.13	0.53	0.33																					
V_1T_4	0	0	0.27	1.27	0.20	0.33	0.40	0.07	0	0.20	0.33	0.40	0.20	0.27	0.27	0.40	0	0	0.07	0.07	0.13						
V_2T_1	0.80	0	0	0	11.67	3.20	1.33	0.27	0	0	0	0.07	0.33	0.30	0.20	0	0	0	0	3.11	0.87	0.67	0.33	0	0.07	5.80	[illegible]
V_2T_2	2.53	2.53	0.35	0.74	13.40	3.00	2.33	0.40	0.33	0.13	0.27	0.33	4.00	5.13	0.07	0.13	0	0	0.07	2.07	0.07	0	0	0	0	0	[illegible]
V_2T_3	0.80	0.67	0.45	0	9.80	2.00	1.67	0.73	0.56	0.40	0.53	0.67	1.53	0.85	0.27	0	0	0	0.27	0.30	0.07	0	0	0	0	2.13	2.00
V_2T_4	1.07	0.93	0.87	0	3.13	0.67	0.93	1.20	1.00	0.87	1.23	1.57	0.53	0.40	0.07	0	0	0.67	1.80	0	0.67	0	0	0	0.67	2.13	2.57
V_3T_1	1.33	0.07	0	0.13	3.47	1.47	1.33	0.33	0.07	0	0.07	0.33	0.60	0.93	0	0	0	0	0	0	0.20	0	0	0	0	1.27	1.53
V_3T_2	0.07	0	0	0	7.80	1.80	1.33	0.07	0	0	0.33	0.67	1.37	1.53	0	0.07	0	0	0	0.13	0	0	0	0	0	1.47	1.53
V_3T_3	1.00	0.87	0.73	0.20	5.73	1.13	1.00	0.33	0.07	1.20	1.33	1.67	2.27	1.67	0	0	0	0.47	0.37	0.80	0.13	0	0	0	0.40	2.80	2.53
V_3T_4	0.73	0.67	0.07	0.40	0	0	0.07	0.07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.07	0.13	0.33

Treat-ment no:	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	Total number of flowers per plant
								April 1983									
								Days after sowing									
		115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	
V_1T_1																	42.55
V_1T_2																	11.33
V_1T_3																	23.14
V_1T_4																	12.05
V_2T_1	1.53	0	0	0.33	0.53	1.40	0.87	0.33	0.53	0.67	1.87	3.53	2.27	1.77	0.73	0.27	150.30
V_2T_2	1.27	0	0	0.47	0.53	1.40	0	0	0.07	0.33	0.60	0.93	0.33	0.27	0.47	0.73	125.17
V_2T_3	0.47	0	1.33	1.07													31.94
V_2T_4	0.07	0	0	1.00	1.07	0.60	0.67	0.87	0.93	1.13							55.64
V_3T_1	0	0	0	0.07	0.13	0.13	0	0	0	0.13	0.20	0.27	0.67	0	0	0.13	39.34
V_3T_2	0	0	0	0.07	0.13	0	0	0	0	0.07	0.07	0.13					77.44
V_3T_3	0	0	0.67	0.67	0.87	0	0	0	0	0.07	0.13	1.13					70.17
V_3T_4	0.07	0	0	0.07	0.07	0.07	0.07	0.07									10.00

FIG. 5.1 DAILY FLOWER PRODUCTION IN TMV2

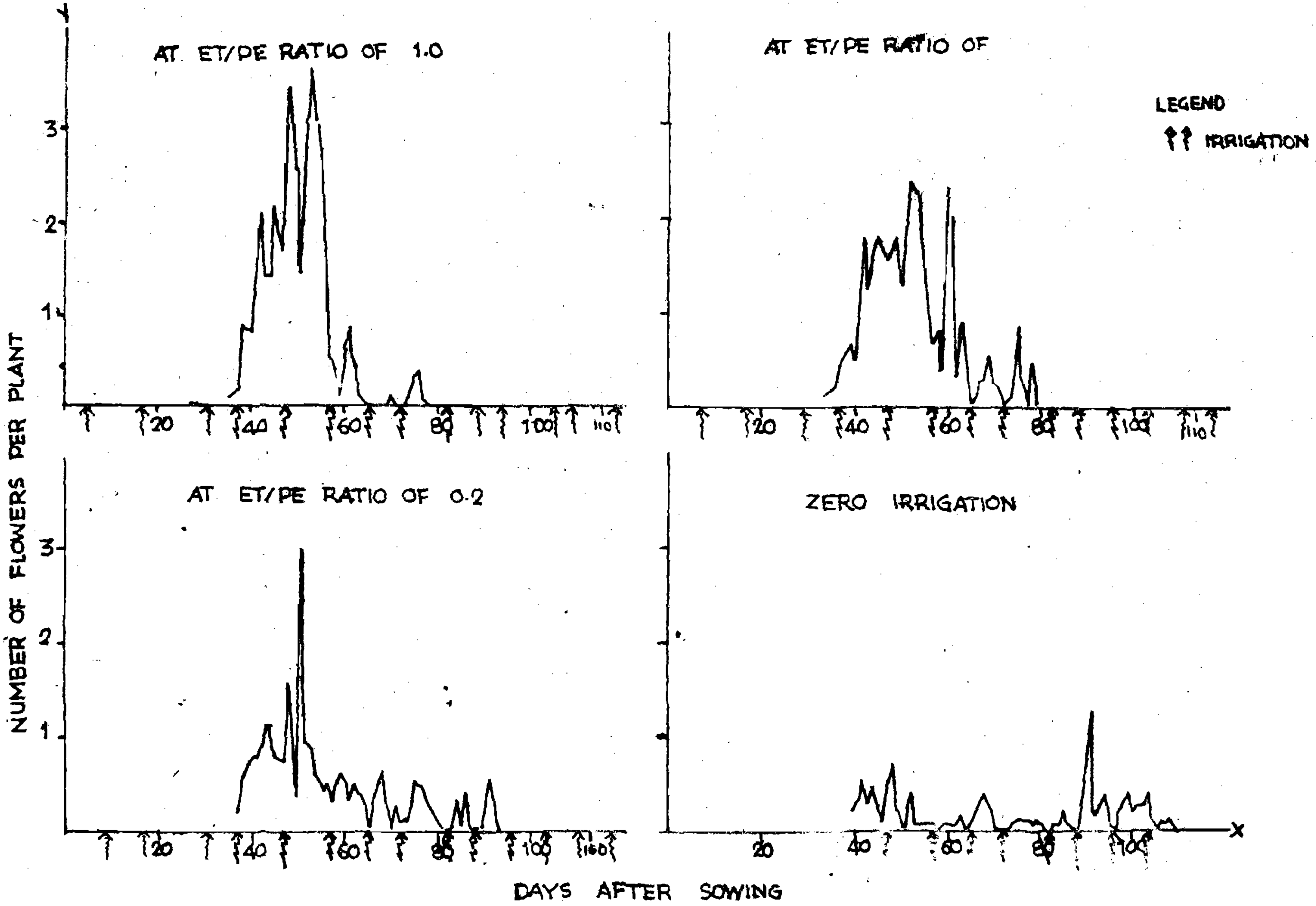


FIG. ... DAILY FLOWER PRODUCTION IN KADIRI 1

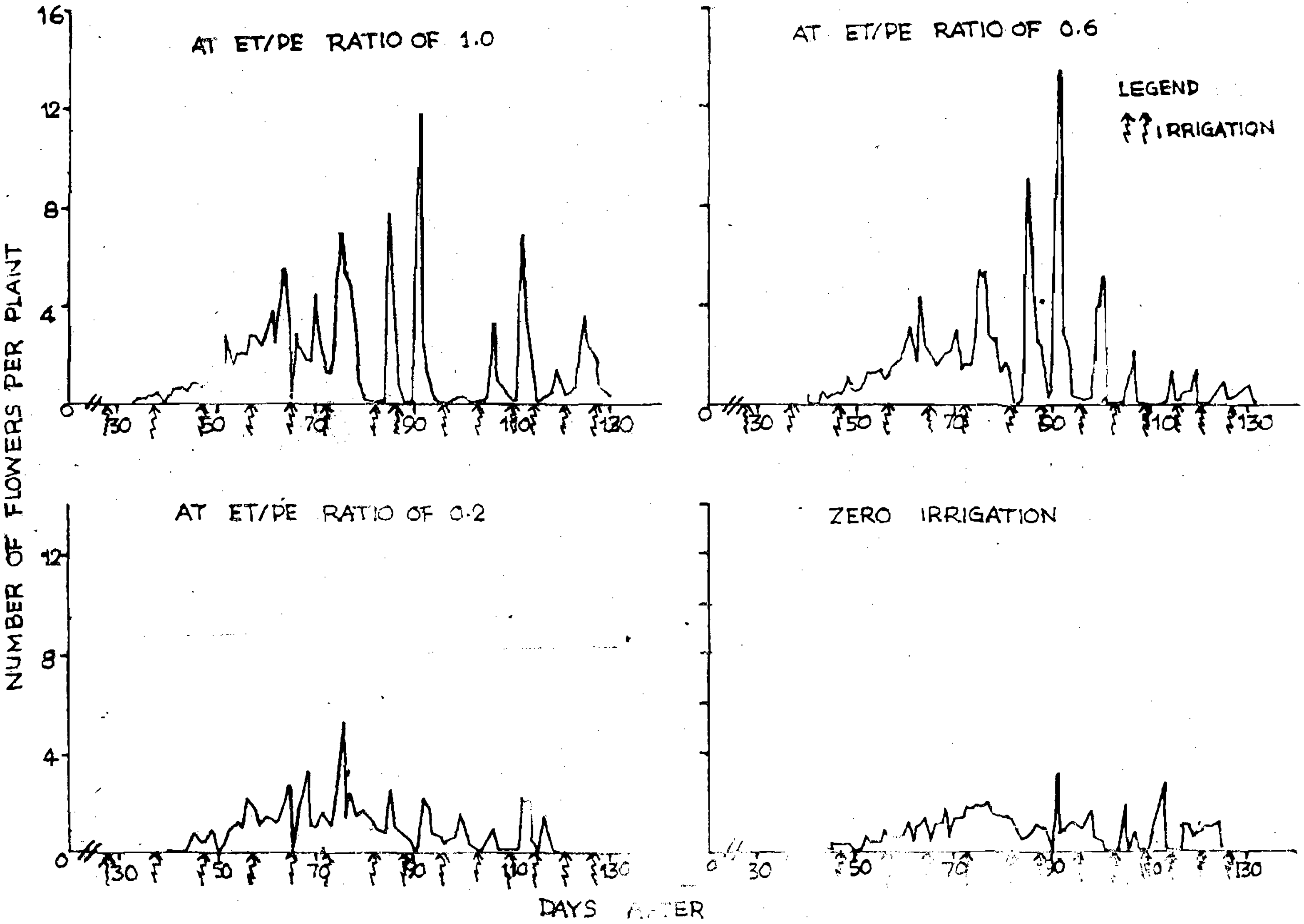
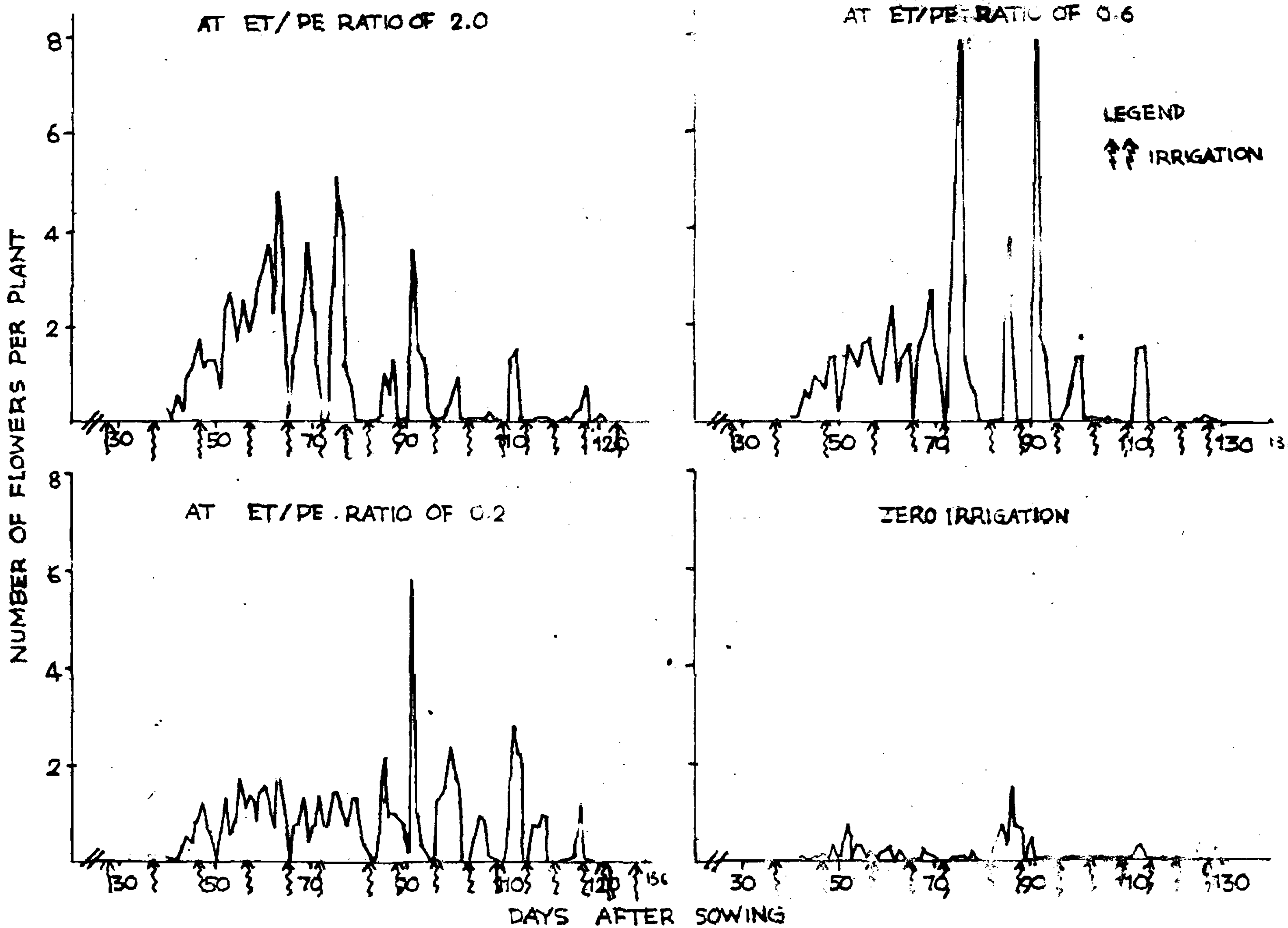


FIG. 5.3 ... PRODUCTION IN KADIRI 2



produced with decreasing soil moisture regimes. The reduction in the flower production was gradual and marginal between various irrigation treatments, except the last treatment which received no irrigation. The drop in flower production was 25 between first two treatments of irrigation and the differences between the other treatments were much more in Kadiri-1. In Kadiri-2 the flower production gradually declined upto T_3 and T_4 recorded minimal values.

Among the varieties maximum number of flowers were produced by Kadiri-1 followed by Kadiri-2 and TMV-2 at all irrigation levels. There was a delay in the appearance of flowers with decrease in irrigation level in TMV-2 and almost similar trend was found in other two varieties also. The data on daily flower count indicated that maximum number of flowers were produced during the early phase of the crop growth irrespective of treatments and varieties. It is interesting to note that the number of flowers produced per day was not influenced by the irrigation levels; however, the intensity of irrigation did reflect on the maximum flower production per day. In the later phenophases of the crop, the flower production was strictly controlled by the irrigation. There was an increase in the number of flowers produced per day and reached a peak within three to four days after irrigation and flower production gradually declined and reached zero values before next irrigation. Thus flower peaks never reached zero levels at the earlier phenophases whereas there were number of peaks which touched zero values at later phases of crop growth in tune with the time of irrigation.

4.1.5 Number of pegs

Pegs were started appearing right from the 50th day sample onwards in all the three varieties under normal conditions (Table 6 and Fig.6). Maximum number of pegs within each treatment were observed at 80th day sample in TMV-2 in all the treatments and by 90th day in the other two cultivars irrespective of the treatments. Peg production was retarded with moisture stress (T_3 and T_4).

Number of pegs per plant declined with increasing moisture stress in all the cultivars. Maximum pegs were observed in the final sample in T_1 in the case of TMV-2 whereas in Kadiri-1 and Kadiri-2 cultivars and maximum pegs were noted in T_2. The number of pegs per plant were negligible at low soil moisture availability in all the cultivars. Moisture stress reduced the pegs per plant.

The differences between main and sub-treatments and their interactions were statistically significant.

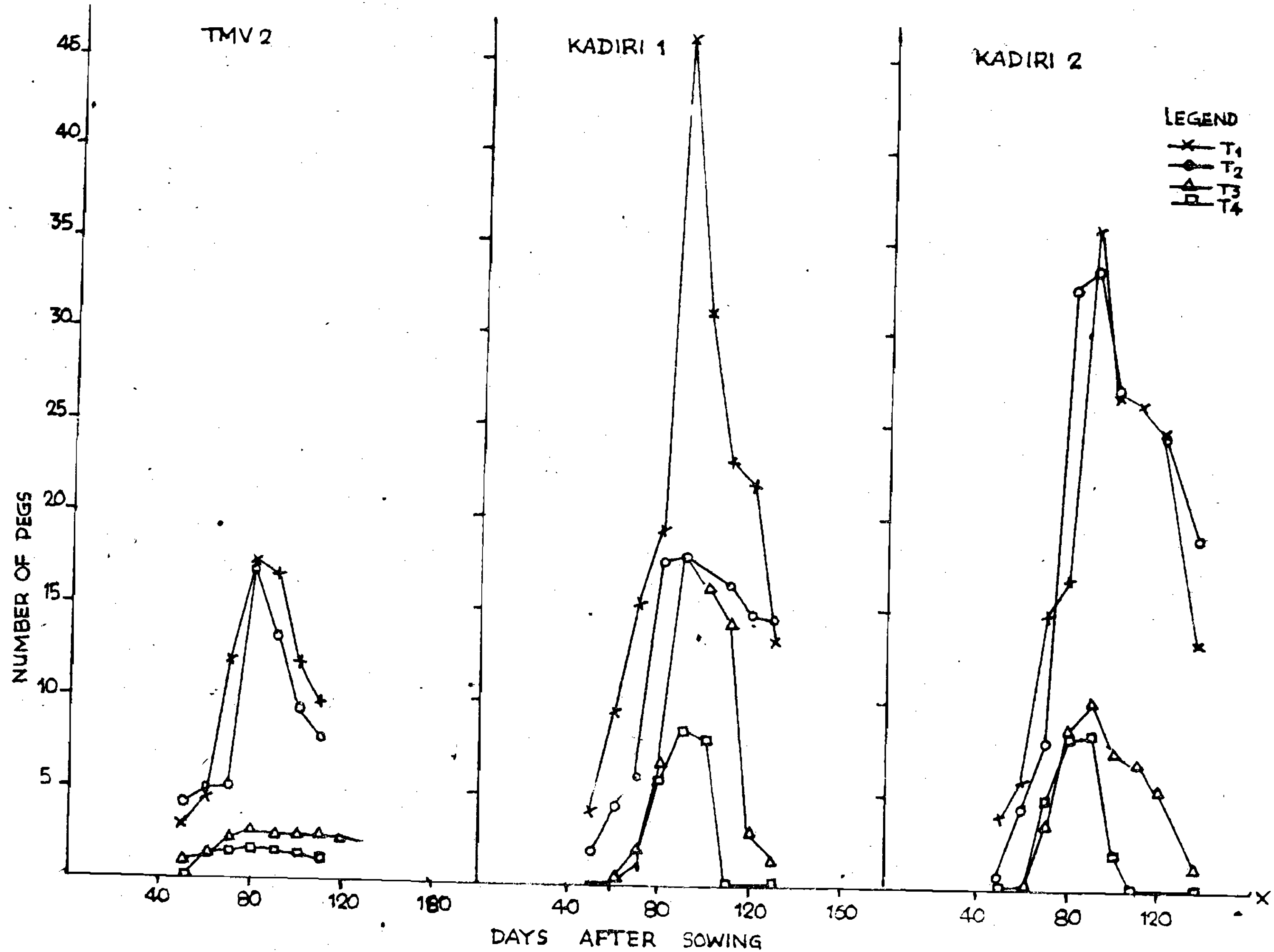
4.1.6 Number of pods

Pods started appearing right from 50th day in the case of TMV-2 and 70th day in the case of other two cultivars under normal irrigation regime (1.0 of ET/PE ratio).

TABLE 6: Number of pegs per plant

Treatments	Days after sowing								
	50	60	70	80	90	100	110	120	136
V_1 T_1	3.00	4.33	11.78	17.45	16.69	11.78	9.60		
V_1 T_2	4.22	4.89	5.11	16.67	13.33	9.44	7.78		
V_1 T_3	1.00	1.22	2.22	2.56	2.44	2.44	2.40		
V_1 T_4	0	1.44	1.56	1.67	1.44	1.11	1.08		
V_2 T_1	5.33	9.55	15.44	19.33	46.22	31.22	23.11	21.78	13.27
V_2 T_2	1.78	4.33	6.00	17.66	17.78	17.00	16.33	14.78	14.44
V_2 T_3	0	0.33	2.00	6.78	18.00	16.22	14.33	3.11	1.60
V_2 T_4	0	0	1.22	5.78	8.44	8.11	0	0	0
V_3 T_1	3.89	5.88	15.11	17.11	36.11	27.00	26.56	25.00	13.53
V_3 T_2	0.78	4.44	8.00	32.78	33.67	27.33	26.33	24.66	19.20
V_3 T_3	0	0	2.89	8.78	10.22	7.55	7.00	5.55	1.33
V_3 T_4	0	0.33	4.89	8.22	8.33	1.89	0	0	0
C.D. at 5% for									
Treatments	0.25	0.23	0.27	0.49	0.57	0.87	0.32	0.22	0.39
Varieties	0.18	0.21	0.29	0.40	0.41	0.39	0.27	0.41	0.44
Interactions	0.37	0.41	0.58	0.80	0.82	0.79	0.56	0.82	0.88

FIG. 6 NUMBER OF PEGS PER PLANT AT VARIOUS STAGES OF CROP GROWTH



In TMV-2, maximum number of pods were produced between 60th and 80th day after sowing in the case of first two soil moisture regimes (Table 7 and Fig. 7). There was a delay in pod production with extreme stress treatments. The addition of pods was negligible after 80th day in the case of first two irrigation treatments whereas pod production continued till harvest in the case of other two treatments with severe moisture stress. The difference between first two treatments and last two treatments was almost 50 per cent. Maximum pod production was observed between 80th and 100th day in the case of Kadiri-1 and Kadiri-2. There was a delay in pod production with increase in moisture stress. The stress treatments reduced the pod production in Kadiri-1 and Kadiri-2. Among the first two irrigation treatments, T_2 realised more pods in spreading and semispreading cultivars. The difference between first two treatments was marginal. There was drastic reduction in the pods produced by plants subjected to irrigation level below ET/PE ratio of 0.6.

The differences between main and sub-treatments and their interactions were significant.

4.2 PHYSIOLOGICAL ATTRIBUTES

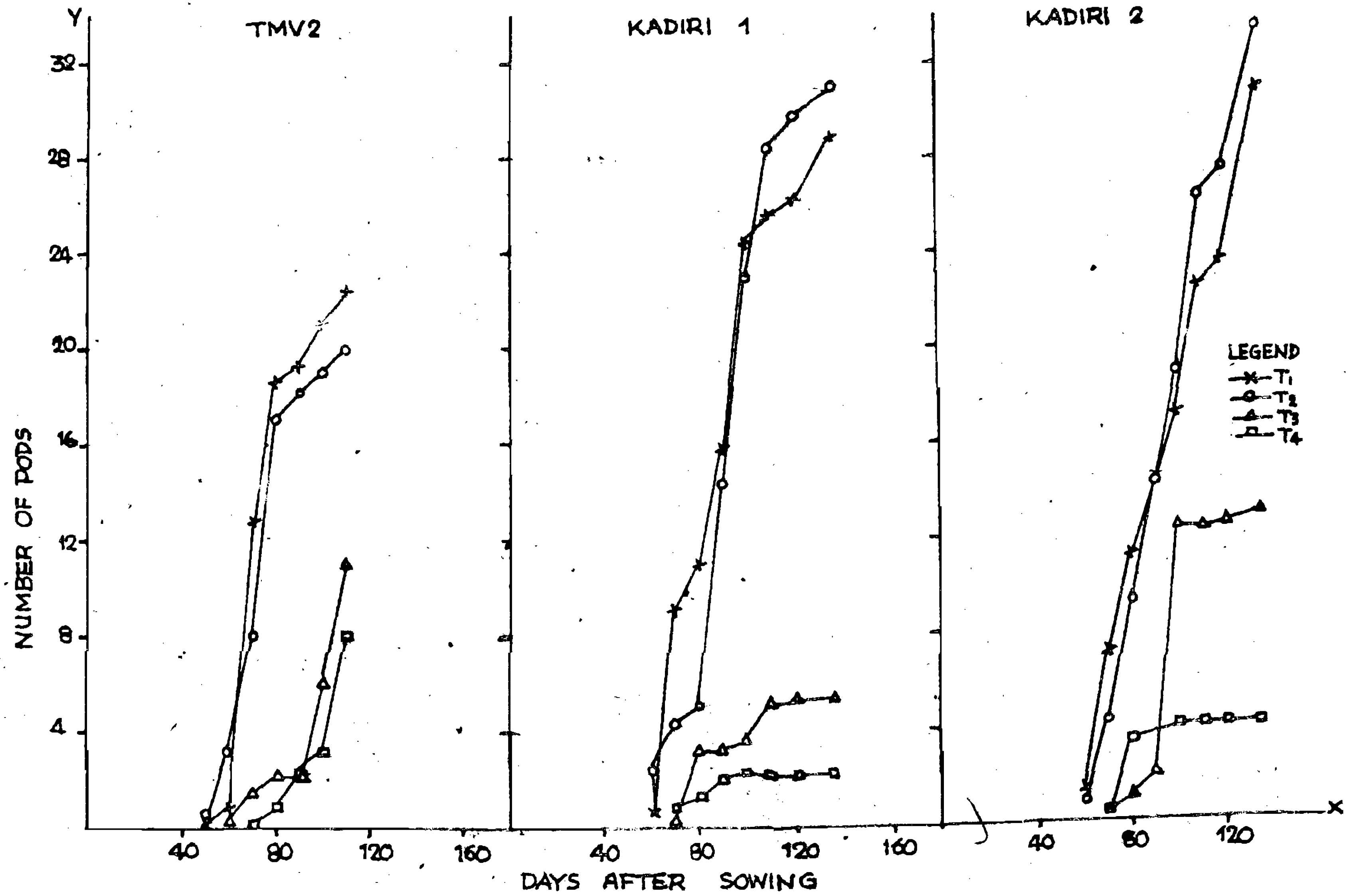
4.2.1 Leaf area index (LAI)

Maximum leaf area index was observed at the time of harvest in TMV-2 and at about 100 days in Kadiri-1 and 120 days in Kadiri-2 under normal irrigated situations (Table 8 and Fig. 8).

TABLE 7: Number of pods per plant

Treatments	Days after sowing								
	50	60	70	80	90	100	110	120	136
$V_1 T_1$	0.33	0.77	12.78	18.67	19.33	20.89	22.53		
$V_1 T_2$	0.66	3.22	8.44	17.11	18.55	19.33	20.27		
$V_1 T_3$	0	0.33	1.44	2.11	2.11	6.33	11.07		
$V_1 T_4$	0	0	0.22	0.78	2.33	3.33	8.11		
$V_2 T_1$	0	0.66	9.11	10.89	15.78	24.44	25.67	26.33	28.87
$V_2 T_2$	0	2.55	4.56	5.11	14.56	23.11	28.55	29.78	31.00
$V_2 T_3$	0	0	0.22	3.22	3.33	3.67	5.33	5.44	5.47
$V_2 T_4$	0	0	0.89	1.22	1.89	2.33	2.33	2.33	2.47
$V_3 T_1$	0	1.55	7.11	11.11	14.00	17.00	22.56	23.55	30.73
$V_3 T_2$	0	0.77	4.33	9.33	14.33	18.77	26.11	27.33	32.27
$V_3 T_3$	0	0	0.44	1.11	2.00	12.22	12.33	12.44	12.80
$V_3 T_4$	0	0	0.44	3.44	3.67	3.89	4.00	4.00	4.00
C.D. at 5% for									
Treatments		0.09	0.42	0.60	0.28	0.38	0.43	0.47	0.83
Varieties		0.04	0.21	0.34	0.24	0.29	0.35	0.52	0.37
Interaction		0.07	0.43	0.67	0.48	0.59	0.69	1.05	0.75

FIG.7. NUMBER OF PODS PER PLANT AT VARIOUS STAGES OF CROP GROWTH



Maximum rate of leaf expansion was observed between 60 and 70 days in TMV-2 and Kadiri-2 and between 80 and 90 days in Kadiri-1. A leaf area index of about 3.0 which is required for complete ground cover was achieved by 100th day in TMV-2, by 90th day in Kadiri-1 and Kadiri-2 under normal irrigated conditions. Thus leaf expansion was found to be faster in the case of spreading and semi-spreading varieties than TMV-2, a bunch cultivar.

The differences between first two treatments were not marked whereas differences between the last two treatments were quite discernable. In otherwords, milder stress did not affect leaf area index in TMV-2. In spreading and semispreading cultivars there were marked differences between first two irrigation treatments and the leaf area index was much affected by last two irrigation treatments and these two varieties exhibited same behaviour in leaf number and leaf area index in all treatments. In TMV-2 there was gradual decline in leaf number with decrease in the quantity of water supply, whereas leaf expansion suffered most with last two irrigation treatments.

The differences between main and sub-treatments and their interactions were statistically significant.

4.2.2 Leaf area ratio (LAR)

The leaf area ratio (Table 9) at the earlier stages of crop growth was less and later on increased and peaked by 60th day in TMV-2 and Kadiri-1 and 70th day in Kadiri-2 and then declined in in the later part of the crop growth in T_1 treatment. The

TABLE 8: Leaf Area Index (LAI)

Treatment	Days after sowing												
	10	20	30	40	50	60	70	80	90	100	110	120	136
V_1 T_1	0.02	0.07	0.19	0.37	0.66	0.93	1.81	2.00	2.65	3.75	3.77		
V_1 T_2	0.04	0.09	0.23	0.80	0.88	0.92	1.33	2.22	2.72	3.13	3.35		
V_1 T_3	0.03	0.06	0.17	0.25	0.36	0.46	0.66	0.71	0.71	0.85	1.14		
V_1 T_4	0.04	0.06	0.11	0.23	0.26	0.33	0.38	0.45	0.68	0.73	0.93		
V_2 T_1	0.01	0.03	0.13	0.25	0.70	1.17	2.58	2.87	4.05	4.56	3.70	3.36	3.20
V_2 T_2	0.02	0.04	0.08	0.22	0.70	1.20	1.61	1.88	2.07	3.19	3.10	2.55	2.31
V_2 T_3	0.02	0.02	0.06	0.13	0.25	0.37	0.49	0.88	1.04	1.11	1.16	0.58	0.56
V_2 T_4	0.01	0.02	0.04	0.05	0.14	0.17	0.36	0.56	0.59	0.75	0.76	0.45	0.40
V_3 T_1	0.03	0.05	0.14	0.26	1.03	1.79	2.51	2.93	3.39	3.89	4.25	4.48	4.15
V_3 T_2	0.02	0.04	0.14	0.38	0.98	1.43	1.54	1.97	2.89	3.28	3.64	3.46	3.37
V_3 T_3	0.03	0.04	0.10	0.19	0.40	0.57	0.58	0.93	1.01	1.11	1.10	0.62	0.61
V_3 T_4	0.02	0.03	0.09	0.16	0.22	0.32	0.51	0.78	0.60	0.49	0.48	0.46	0.46
C.D. at 5% for													
Treatments	0.002	0.005	0.015	0.036	0.071	0.090	0.31	0.04	0.05	0.05	0.03	0.05	0.04
Varieties	0.001	0.004	0.015	0.019	0.038	0.040	0.24	0.07	0.03	0.04	0.04	0.03	0.02
Interactions	0.003	0.007	0.031	0.039	0.076	0.090	0.48	0.14	0.07	0.08	0.09	0.06	0.04

FIG.8 LEAF AREA INDEX AT VARIOUS STAGES OF CROP GROWTH

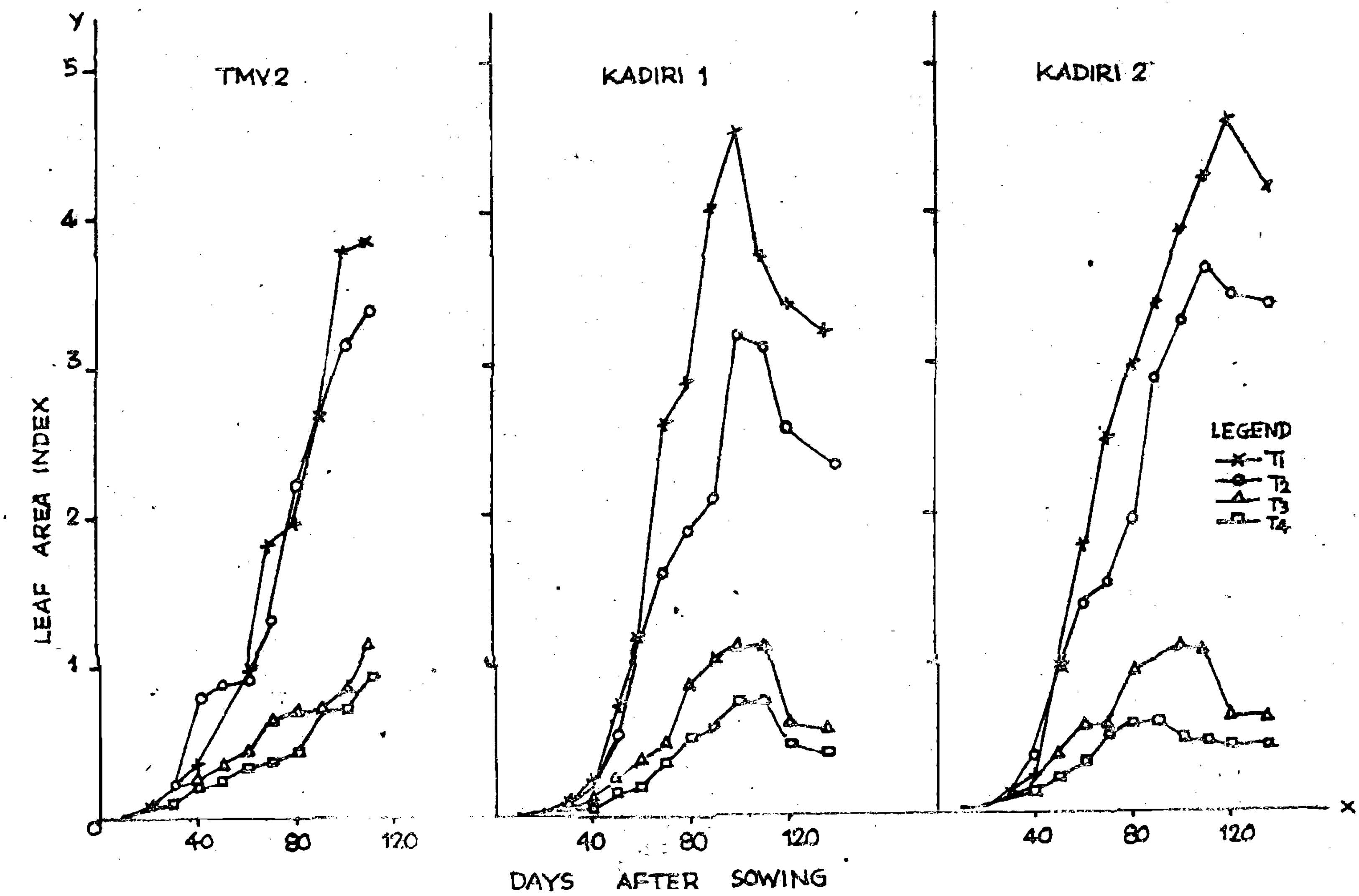


TABLE 9: Leaf area ratio (L.A.R)

Treatment	Days after sowing												
	10	20	30	40	50	60	70	80	90	100	110	120	1
V_1 T_1	46.82	74.22	111.79	112.93	109.78	117.45	77.74	48.73	64.10	79.78	59.02		
V_1 T_2	90.68	86.64	119.19	137.84	86.66	73.38	76.51	65.97	57.00	77.86	52.25		
V_1 T_3	63.64	86.20	97.32	102.13	87.68	76.47	98.52	73.73	71.08	49.57	55.05		
V_1 T_4	68.48	76.69	117.82	117.18	91.96	89.83	66.59	51.28	87.73	87.69	87.52		
V_2 T_1	61.41	71.31	136.28	126.36	113.33	117.45	114.88	79.07	71.48	71.63	67.15	59.37	5
V_2 T_2	96.49	94.46	106.97	100.10	105.28	103.30	93.16	64.48	74.46	81.87	87.99	80.84	6
V_2 T_3	70.73	78.57	92.14	116.89	99.65	92.80	89.10	91.50	83.56	74.52	79.08	71.72	5
V_2 T_4	77.29	62.64	95.55	63.62	128.07	103.79	88.86	93.78	32.03	67.73	74.91	61.57	6
V_3 T_1	75.79	89.43	115.09	105.22	115.81	116.68	121.88	76.11	70.30	76.55	79.44	71.60	5
V_3 T_2	68.86	83.23	67.97	123.49	116.28	134.27	103.78	67.93	76.60	81.63	87.74	85.37	7
V_3 T_3	91.32	58.25	88.44	115.87	103.61	90.81	78.60	88.93	90.21	77.10	93.12	66.11	5
V_3 T_4	83.42	77.89	119.61	105.78	100.48	117.32	78.67	68.75	67.06	59.39	69.32	68.40	6

attainment of maximum values in leaf area ratio was preponed with decrease in quantity of irrigation. Thus, there was a shift in leaf area ratio with the type of irrigation treatment. The treatments did not influence the leaf area ratio values and therefore the differences between various treatments failed to show any particular trend.

4.2.3 <u>Dry weight of plant parts</u>

4.2.3.1 <u>Dry weight of root</u>:- The data on dry weight of roots were presented in Table 10 and Fig. 9. Under normal irrigated conditions maximum dry weight of root was observed by 80th day in case of TMV-2 and by 90th day in the case of other two varieties. Among the varieties, maximum root weight was recorded by Kadiri-2 followed by Kadiri-1 and TMV-2. The dry weight of roots decreased with increased soil moisture stress. The same trend was observed in the other two cultivars.

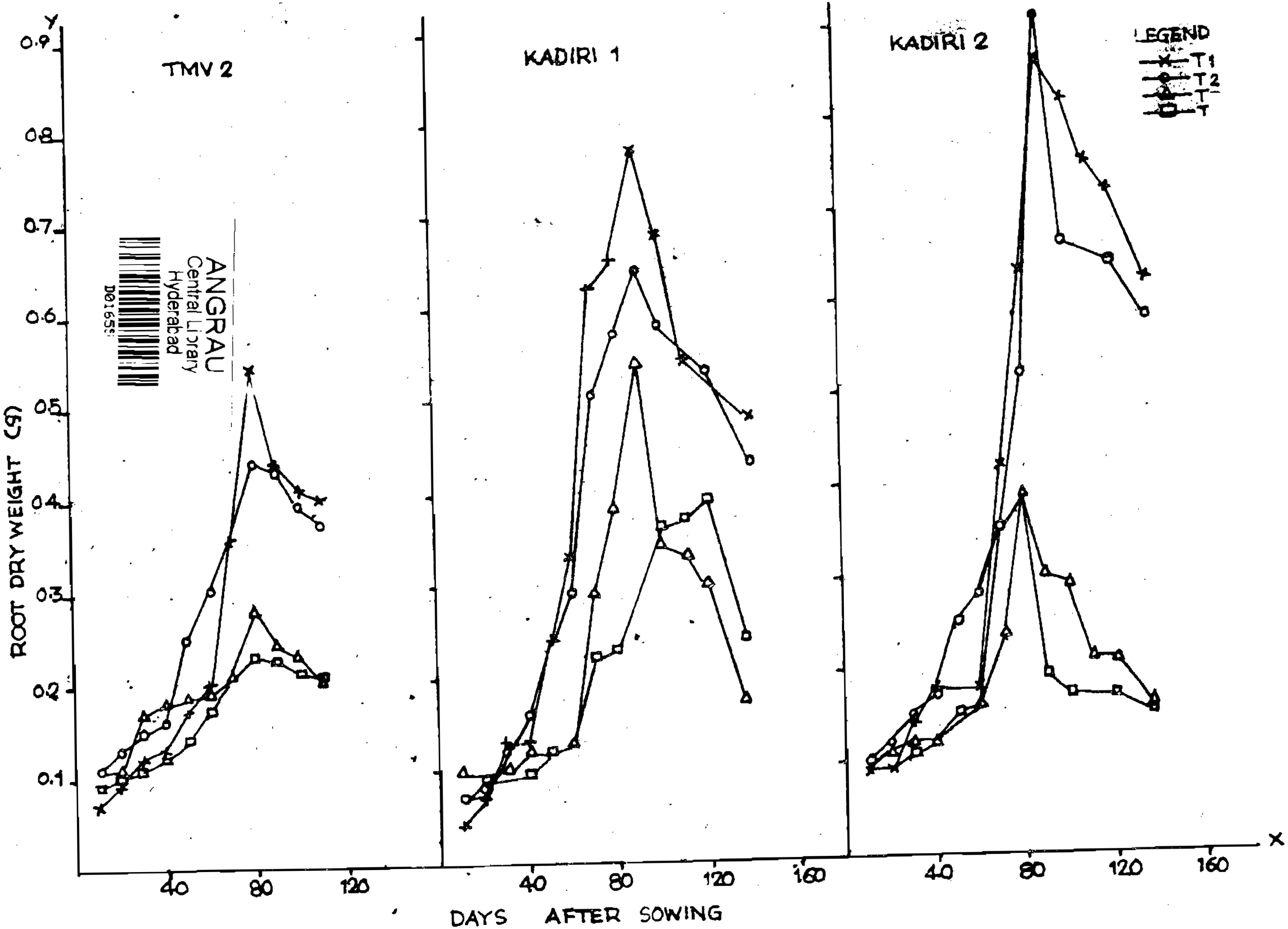
In all the three cultivars the difference in dry weight of root was not marked with the first two treatments of irrigation whereas the last two extreme treatments reduced root dry weight drastically and the differences between first two treatments (T_1 and T_2) and the last two treatments (T_3 and T_4) were very marked.

The differences between main and sub-treatments and their interactions were statistically significant.

TABLE 10: Dry weight of root per plant (g)

Treatment	Days after sowing												
	10	20	30	40	50	60	70	80	90	100	110	120	136
V_1 T_1	0.07	0.09	0.12	0.13	0.17	0.20	0.35	0.54	0.44	0.41	0.40		
V_1 T_2	0.11	0.13	0.15	0.16	0.25	0.30	0.36	0.44	0.43	0.39	0.37		
V_1 T_3	0.11	0.11	0.17	0.18	0.18	0.19	0.21	0.28	0.24	0.23	0.20		
V_1 T_4	0.09	0.10	0.11	0.12	0.14	0.17	0.21	0.23	0.23	0.21	0.20		
V_2 T_1	0.04	0.07	0.13	0.13	0.23	0.33	0.62	0.65	0.77	0.68	0.54	0.52	0.48
V_2 T_2	0.07	0.08	0.12	0.16	0.24	0.29	0.50	0.57	0.64	0.58	0.55	0.53	0.43
V_2 T_3	0.10	0.10	0.10	0.12	0.12	0.13	0.29	0.39	0.53	0.34	0.33	0.30	0.17
V_2 T_4	0.07	0.09	0.09	0.09	0.12	0.13	0.22	0.23	0.26	0.36	0.37	0.39	0.24
V_3 T_1	0.09	0.09	0.14	0.18	0.18	0.18	0.42	0.63	0.86	0.82	0.75	0.72	0.62
V_3 T_2	0.10	0.12	0.15	0.17	0.25	0.28	0.36	0.52	0.91	0.66	0.65	0.64	0.58
V_3 T_3	0.09	0.11	0.12	0.12	0.14	0.16	0.23	0.39	0.30	0.29	0.21	0.21	0.16
V_3 T_4	0.09	0.10	0.11	0.12	0.15	0.16	0.35	0.37	0.19	0.17	0.17	0.17	0.15
C.D. at 5% for													
Treatments	0.11	0.003	0.005	0.002	0.006	0.097	0.018	0.034	0.032	0.021	0.019		
Varieties	0.08	0.002	0.007	0.001	0.004	0.074	0.021	0.027	0.023	0.027	0.023		
Interactions	0.16	0.003	0.014	0.003	0.008	0.149	0.042	0.054	0.046	0.053	0.047		

FIG. 9 DRYWEIGHT OF ROOTS PER PLANT (g)



4.2.3.2 Dry weight of stem:- Initially there was a slow accumulation of dry matter in the stem during the first 40 days after sowing in all the cultivars irrespective of the treatments (Table 11 and Fig. 10). Maximum stem dry weight was observed by 80th day in the case of TMV-2, by 100th day in the case of Kadiri-1 and by 110th day in the case of Kadiri-2. The rate of dry matter accumulation in stems was more between 60th and 80th day in TMV-2 and Kadiri-1 and between 70th and 80th day in Kadiri-2. More dry weights were recorded by Kadiri-1 a runner followed by Kadiri-2 and TMV-2.

There was a marked difference between T_1 and T_2 in respect of stem dry weight in TMV-2 whereas such differences between these two treatments were not marked in other two cultivars. The difference between first treatment to that of last treatment was as high as four grams in the case of TMV-2, 9 grams in the case of Kadiri-1 and about six grams in the case of Kadiri-2. The last two treatments decreased the stem dry weight drastically and the dry weights recorded with these treatments by all the three cultivars represent minimal possible values of a plant.

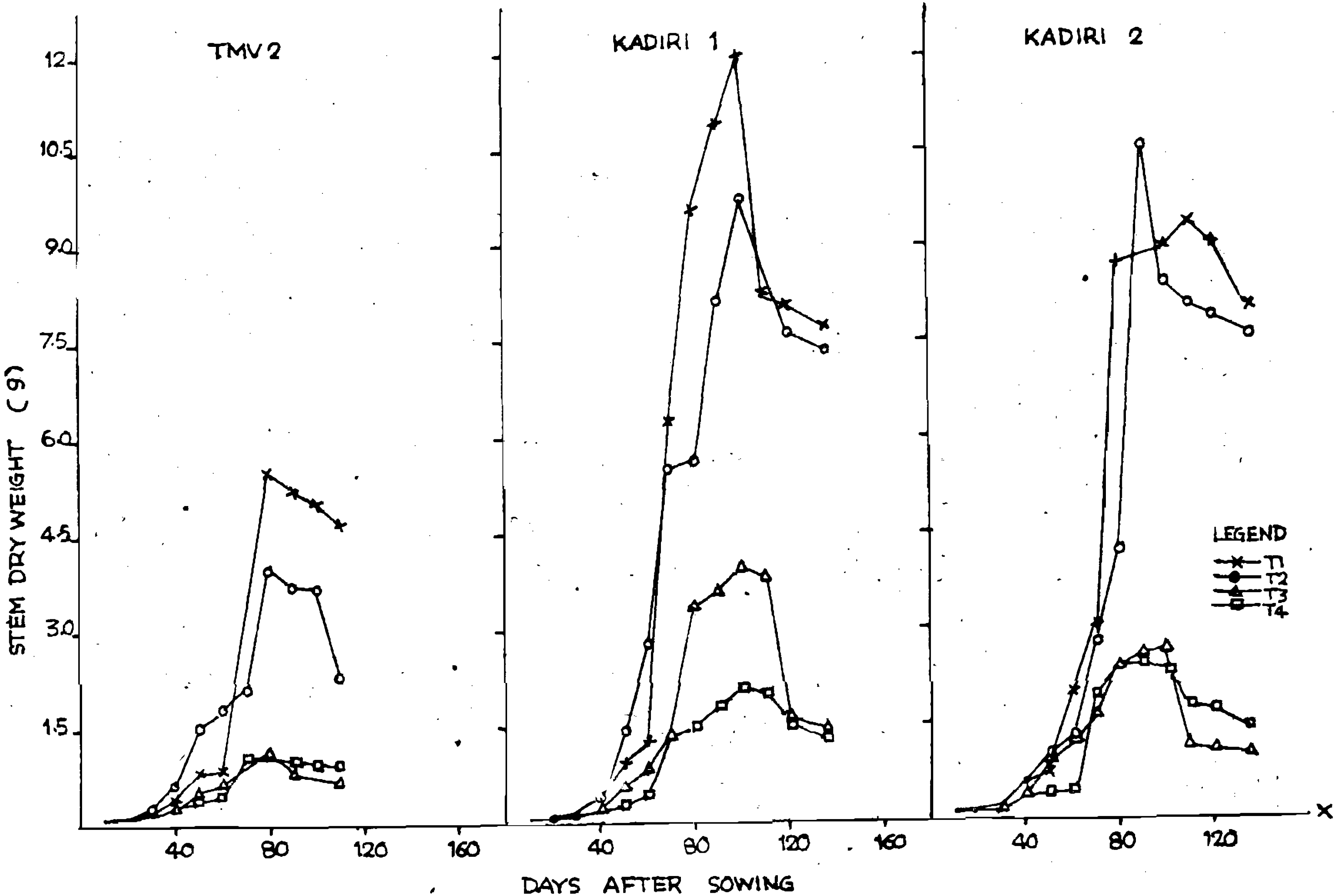
The differences between main and sub-treatments and their interactions were statistically significant.

4.2.3.3 Dry weight of petioles:- There was a gradual increase in dry weight of petioles with crop growth with vertical increase between 50 and 80 days after sowing and peaked at 80th day in

TABLE 11: Dry weight of stem per plant (g)

Treatment	Days after sowing												
	10	20	30	40	50	60	70	80	90	100	110	120	136
$V_1 T_1$	0.10	0.14	0.18	0.43	0.83	0.86	3.03	5.57	5.22	5.02	4.68		
$V_1 T_2$	0.08	0.13	0.24	0.67	1.52	1.89	2.15	3.95	3.73	3.73	2.26		
$V_1 T_3$	0.10	0.11	0.16	0.29	0.48	0.68	0.94	1.12	0.83	0.75	0.70		
$V_1 T_4$	0.10	0.11	0.18	0.26	0.35	0.45	1.06	1.08	1.02	0.97	0.93		
$V_2 T_1$	0.09	0.10	0.17	0.37	0.94	1.60	6.25	9.53	10.90	11.99	8.27	8.09	7.73
$V_2 T_2$	0.07	0.09	0.14	0.39	1.46	2.76	5.49	5.62	8.13	10.53	7.92	7.58	7.33
$V_2 T_3$	0.09	0.10	0.13	0.18	0.52	0.82	1.40	3.31	3.60	3.94	3.85	1.60	1.42
$V_2 T_4$	0.06	0.07	0.09	0.14	0.24	0.37	1.38	1.47	1.76	2.08	1.95	1.49	1.27
$V_3 T_1$	0.11	0.13	0.17	0.50	1.48	1.93	2.99	8.65	8.82	8.88	9.33	8.98	8.05
$V_3 T_2$	0.11	0.12	0.19	0.62	1.01	1.29	2.79	4.16	10.53	8.36	8.07	7.82	7.53
$V_3 T_3$	0.09	0.12	0.13	0.30	0.89	1.55	1.64	2.37	2.55	2.57	1.10	1.01	0.97
$V_3 T_4$	0.09	0.10	0.15	0.31	0.37	0.41	1.83	2.37	2.37	2.42	1.73	1.68	1.41
C.D. at 5% for													
Treatments	0.009	0.008	0.008	0.01	0.06	0.09	0.09	0.17	1.27	0.31	0.15		
Varieties	0.007	0.005	0.005	0.01	0.04	0.04	0.09	0.14	0.77	0.14	0.10		
Interactions	0.010	0.009	0.009	0.03	0.07	0.09	0.18	0.28	1.55	0.28	0.21		

FIG. 10 DRY WEIGHT OF STEM PER PLANT (g)



TMV-2 (Table 12 and Fig. 11). In the case of spreading and semi-spreading varieties the rate of increase in dry matter in petioles was more between 60th and 90th day after sowing and maximum values were recorded on 90th day, after which there was decline in dry weight of petiole till the end of the crop growth.

In all the three cultivars the difference between first two treatment irrigation regimes was not marked and these two treatments produced markedly more dry weights than the other two extreme stress treatments which did not differ with each other markedly.

The differences between main and sub-treatments and their interactions were statistically significant.

4.2.3.4 Dry weight of leaf:- There was a gradual increase in dry weight of leaf throughout the crop growth till harvest in TMV-2. However, maximum growth rate of increase in leaf dry weight was observed between 70th and 80th day after sowing in the first two treatments of moisture regime (Table 13 and Fig. 12). A different dry matter accumulation pattern was observed in spreading and semi-spreading varieties wherein Kadiri-1 produced maximum leaf dry weights by 100th day with maximum rate of growth from 70th day to 100th day in first two soil moisture regimes. On the other hand, such peak was delayed to 110 days in the case of last two stress treatments. In Kadiri-2 there was gradual increase in dry matter of leaves with a peak rates of accumulation

TABLE 12: Dry weight of petioles per plant (g)

Treatment	Days after sowing												
	10	20	30	40	50	60	70	80	90	100	110	120	136
V_1 T_1	0.008	0.02	0.06	0.09	0.18	0.22	0.73	0.83	0.74	0.68	0.58		
V_1 T_2	0.010	0.06	0.07	0.20	0.27	0.29	0.63	1.01	0.91	0.87	0.72		
V_1 T_3	0.010	0.02	0.05	0.08	0.11	0.12	0.21	0.31	0.28	0.26	0.22		
V_1 T_4	0.010	0.02	0.05	0.06	0.15	0.25	0.28	0.30	0.25	0.24	0.22		
V_2 T_1	0.005	0.02	0.06	0.11	0.35	0.59	1.13	1.27	2.01	1.98	1.78	1.75	1.13
V_2 T_2	0.009	0.02	0.04	0.11	0.32	0.56	0.71	0.83	1.74	1.50	1.48	1.38	1.33
V_2 T_3	0.007	0.02	0.04	0.07	0.18	0.30	0.32	0.61	1.04	0.90	0.71	0.35	0.34
V_2 T_4	0.009	0.01	0.02	0.06	0.08	0.10	0.18	0.31	0.98	0.78	0.67	0.61	0.30
V_3 T_1	0.013	0.01	0.06	0.14	0.25	0.61	1.10	1.53	1.93	1.82	1.74	1.71	1.49
V_3 T_2	0.013	0.03	0.08	0.20	0.37	0.85	1.00	1.15	1.75	1.62	1.61	1.56	1.28
V_3 T_3	0.012	0.03	0.05	0.08	0.19	0.32	0.32	0.50	0.56	0.51	0.38	0.30	0.24
V_3 T_4	0.015	0.02	0.06	0.09	0.15	0.21	0.60	0.63	0.33	0.29	0.25	0.22	0.20
C.D. at 5% for													
Treatments	0.001	0.001	0.004	0.01	0.02	0.03	0.03	0.06	0.07	0.06	0.03		
Varieties	0.001	0.001	0.003	0.009	0.02	0.02	0.03	0.04	0.07	0.04	0.05		
Interactions	0.002	0.003	0.007	[illegible]	0.03	0.04	0.06	0.08	0.14	0.07	0.11		

FIG. 11 DRYWEIGHT OF PETIOLE PER PLANT (g)

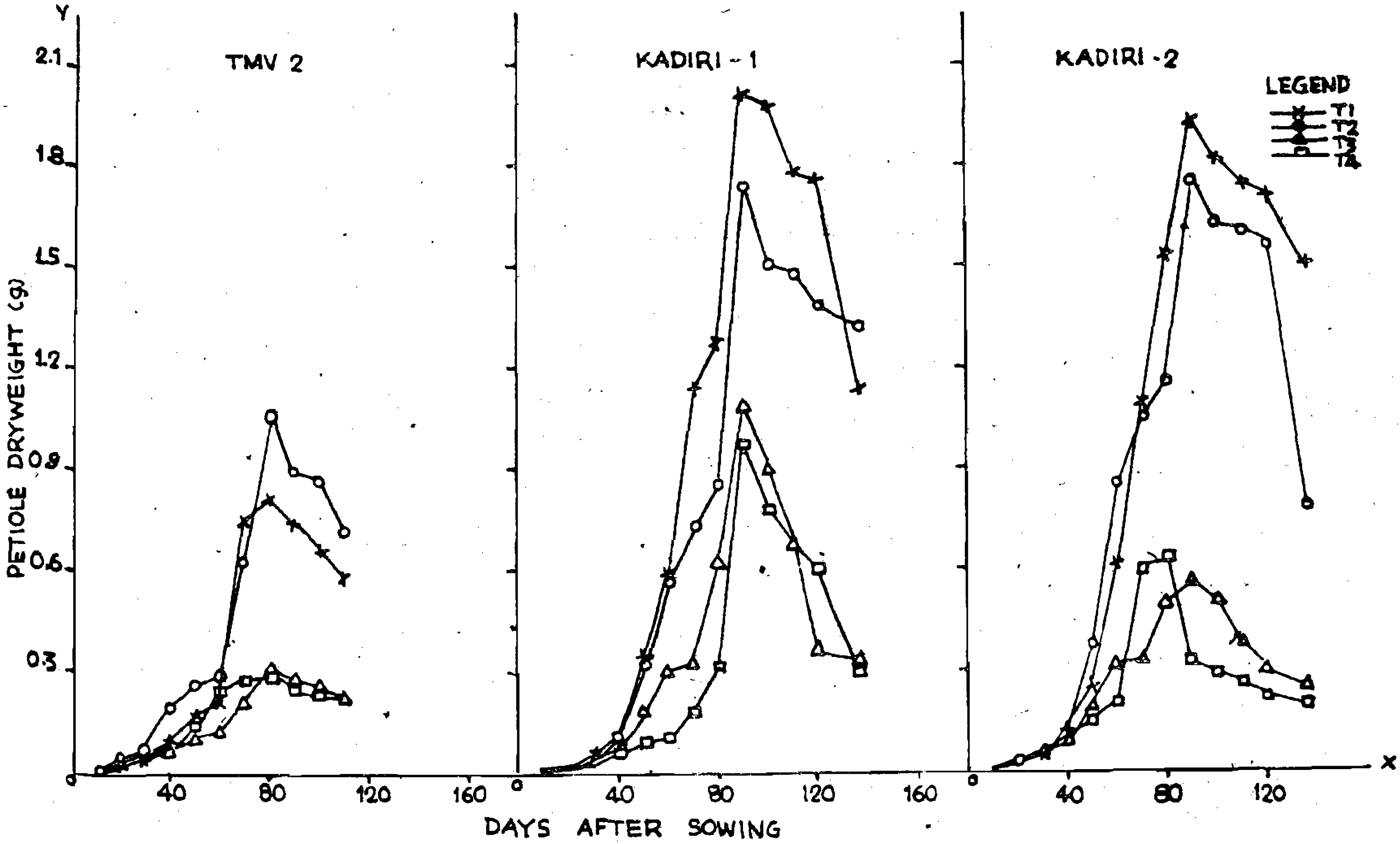
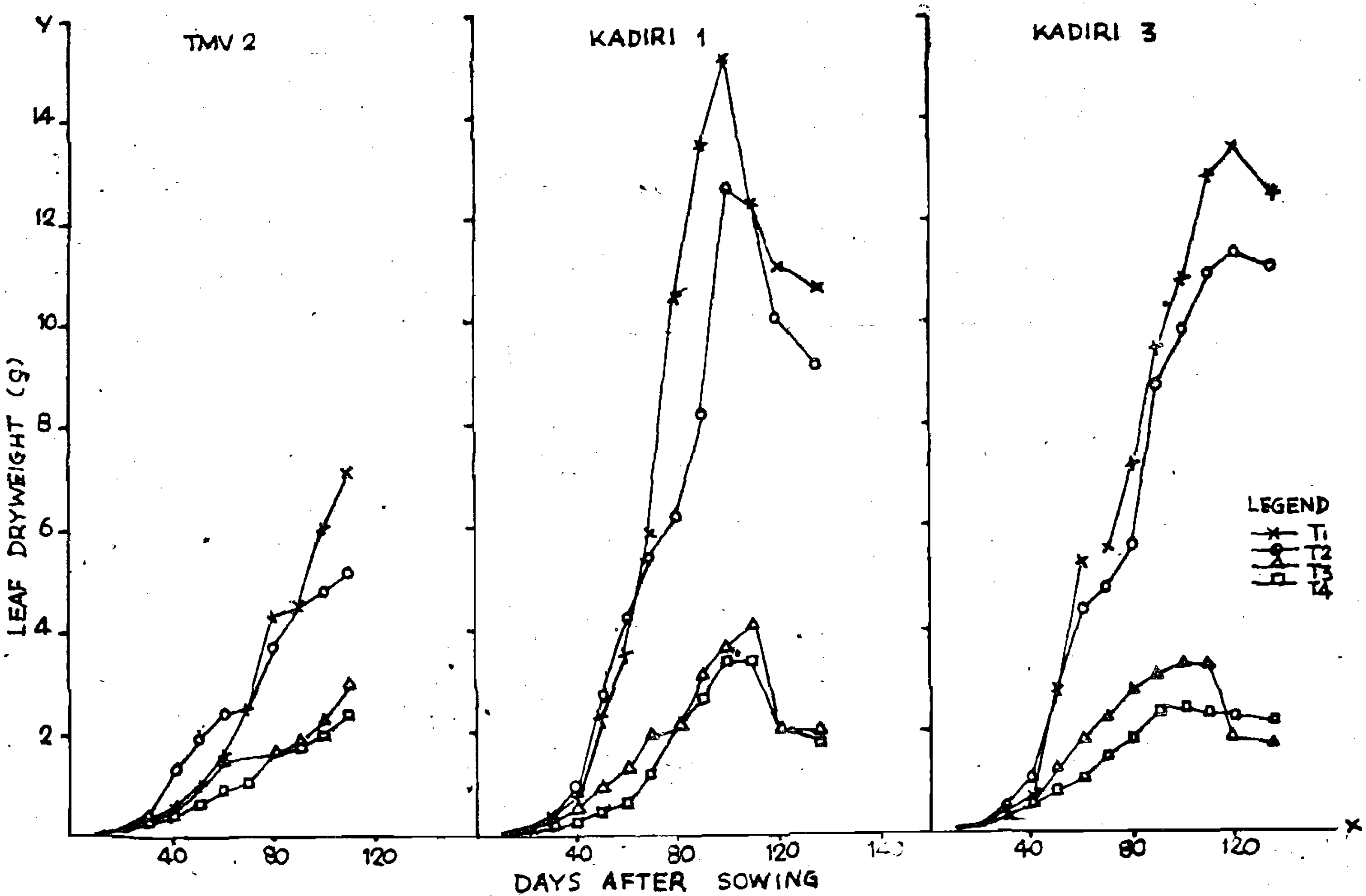


TABLE 13: Dry weight of leaf per plant (g)

Treatment	Days after sowing												
	10	20	30	40	50	60	70	80	90	100	110	120	13
V_1 T_1	0.06	0.17	0.36	0.60	1.03	1.64	2.52	4.30	4.48	5.87	7.02		
V_1 T_2	0.08	0.20	0.43	1.35	1.95	2.39	2.47	3.69	4.46	4.73	5.14		
V_1 T_3	0.08	0.17	0.37	0.48	0.91	1.46	1.54	1.62	1.84	2.22	2.94		
V_1 T_4	0.10	0.14	0.31	0.44	0.67	0.89	1.08	1.60	1.72	1.98	2.37		
V_2 T_1	0.06	0.18	0.37	0.76	2.33	3.51	5.89	10.51	13.53	15.20	12.31	11.20	10.
V_2 T_2	0.05	0.17	0.31	1.00	2.78	4.26	5.42	6.21	8.20	12.65	12.24	10.09	9.
V_2 T_3	0.08	0.12	0.30	0.50	0.89	1.29	1.94	2.09	3.09	3.66	4.05	2.06	1.
V_2 T_4	0.06	0.09	0.17	0.28	0.46	0.64	1.18	2.06	2.68	3.39	3.40	2.02	1.
V_3 T_1	0.09	0.17	0.45	0.70	2.88	5.25	5.56	7.15	9.40	10.81	11.78	12.40	11.
V_3 T_2	0.08	0.15	0.50	1.10	2.78	4.34	4.80	5.62	8.72	9.84	10.91	10.35	10.
V_3 T_3	0.07	0.17	0.39	0.60	1.19	1.33	2.26	2.75	3.07	3.28	3.27	1.85	1.
V_3 T_4	0.08	0.15	0.31	0.55	0.85	1.07	1.90	1.87	2.36	1.92	1.85	1.79	1.
C.D. at 5% for													
Treatments	0.07	0.01	0.05	0.17	0.13	0.12	0.15	0.32	0.11	0.11	0.12		
Varieties	0.05	0.01	0.05	0.13	0.08	0.12	0.29	0.15	0.14	0.19	0.12		
Interactions	0.09	0.02	0.10	0.25	0.17	0.23	0.59	0.29	0.28	0.26	0.24		

FIG · 12 DRYWEIGHT OF LEAVES PER PLANT (g)



at 70th and 80th day in the case of first two treatments and maximum dry matter was recorded on 120th day and later on there was decline in dry weight. Such maximum leaf dry weight was observed at 100th day in T_3 and at 90th day in T_4.

In all the varieties there was decrease in dry matter accumulation in leaves with stress. However, the differences between first two treatments were not marked and reduction in dry weight with second treatment was not appreciable. The last two irrigation treatments drastically reduced the dry matter accumulation in leaves. The reduction in dry matter accumulation with maximum stress treatments (T_4) was as high as 1/3 to 1/10th.

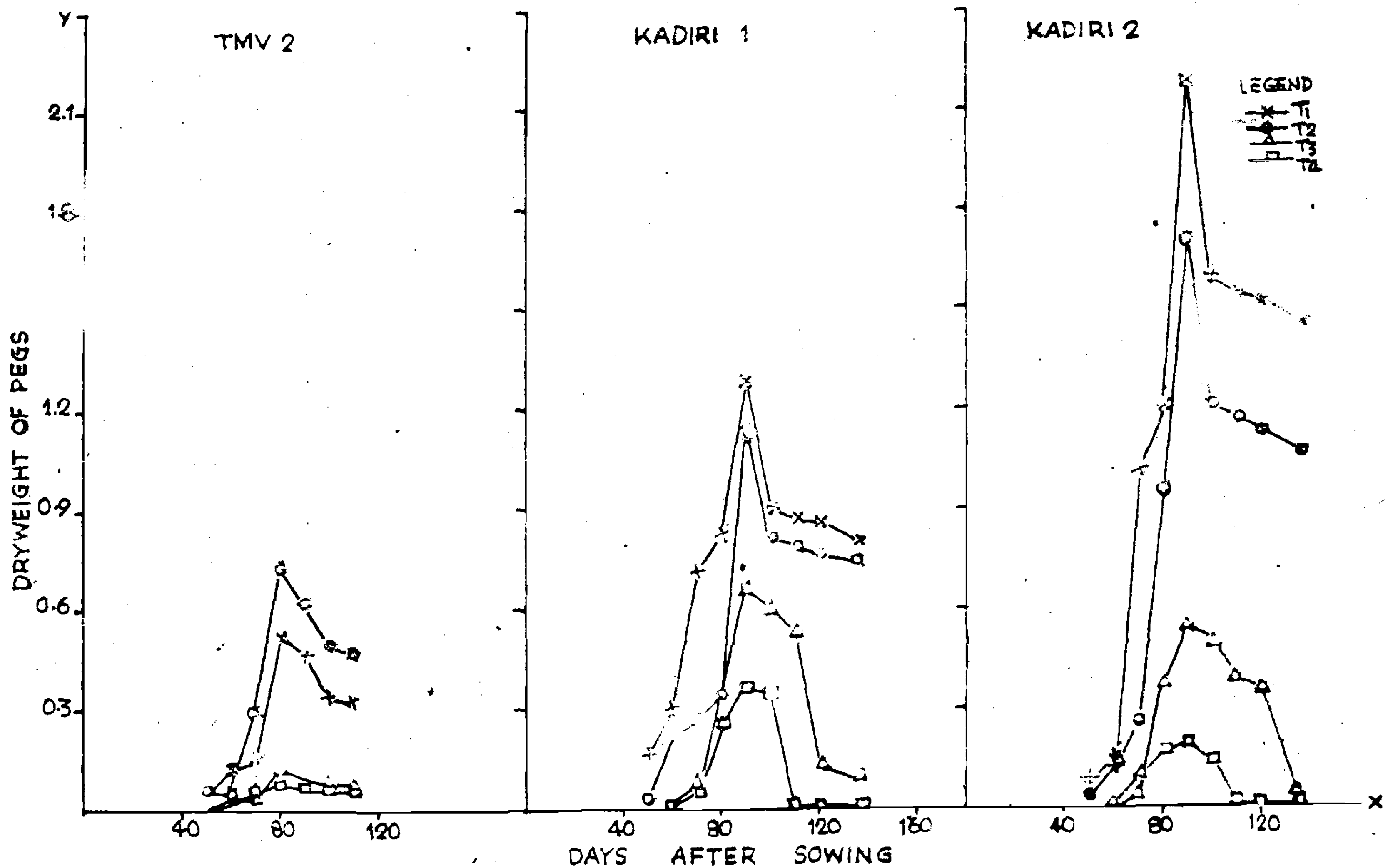
The differences between main and sub-treatments and their interactions were statistically significant.

4.2.3.5 <u>Dry weight of pegs</u>:- The dry matter accumulation in pegs (Table 14 and Fig. 13) observed appearing by 50th day except in severe stress treatments (T_3 and T_4). Maximum dry matter accumulation in pegs was observed by 80th day in TMV-2 in all the treatments with peak rate of accumulation between 70th and 80th day whereas in the other two cultivars the maximum accumulation of dry matter in pegs was observed by 90th day with peak rate of accumulation during the preceeding 10 days. In all the cultivars dry weight of pegs started declining after reaching maximum values.

TABLE 14: Dry weight of pegs per plant (g)

Treatments	Days after sowing								
	50	60	70	80	90	100	110	120	136
V_1 T_1	0.05	0.13	0.15	0.52	0.47	0.34	0.33		
V_1 T_2	0.06	0.06	0.29	0.73	0.62	0.49	0.47		
V_1 T_3	0.01	0.04	0.04	0.13	0.10	0.08	0.07		
V_1 T_4	0	0.03	0.06	0.08	0.07	0.07	0.07		
V_2 T_1	0.16	0.29	0.72	0.88	1.28	0.89	0.87	0.84	0.80
V_2 T_2	0.02	0.22	0.27	0.34	1.14	0.81	0.79	0.76	0.74
V_2 T_3	0	0.01	0.08	0.36	0.67	0.60	0.53	0.12	0.10
V_2 T_4	0	0	0.06	0.25	0.37	0.35	0	0	0
V_3 T_1	0.08	0.15	1.01	1.35	2.19	1.58	1.54	1.52	1.46
V_3 T_2	0.03	0.12	0.26	0.95	1.76	1.21	1.17	1.14	1.07
V_3 T_3	0	0	0.04	0.37	0.54	0.50	0.38	0.36	0.03
V_3 T_4	0	0.01	0.10	0.17	0.19	0.14	0	0	0
C.D. at 5% for									
Treatments	0.005	0.010	0.027	0.047	0.082	0.062	0.058	0.099	0.082
Varieties	0.004	0.008	0.037	0.021	0.038	0.065	0.046	0.047	0.021
Interactions	0.007	0.017	0.075	0.043	0.076	0.129	0.093	0.095	0.042

FIG. 13 DRYWEIGHT OF PEGS PER PLANT (g)



Maximum dry weight of pogs was observed in T_2 of TMV-2 and T_1 of other two cultivars. In general, there was decline in dry matter accumulation in pogs with decrease in soil moisture regime.

The differences between main and sub-treatments and their interactions were statistically significant.

4.2.3.6 Dry weight of pods:- The dry weight of pods indicates oven dry weight. The dry matter accumulation in pods (Table 15 and Fig. 14) was observed appearing by 50th day after sowing in TMV-2 and by 60th day in spreading and semi-spreading varieties. There was a gradual accumulation of dry matter with time in pods. Peak accumulation of dry matter was observed ten days prior to harvest in the case of TMV-2 and 20 days prior to harvest in the case of other two cultivars. Pod dry weight was more with spreading and semispreading varieties than TMV-2.

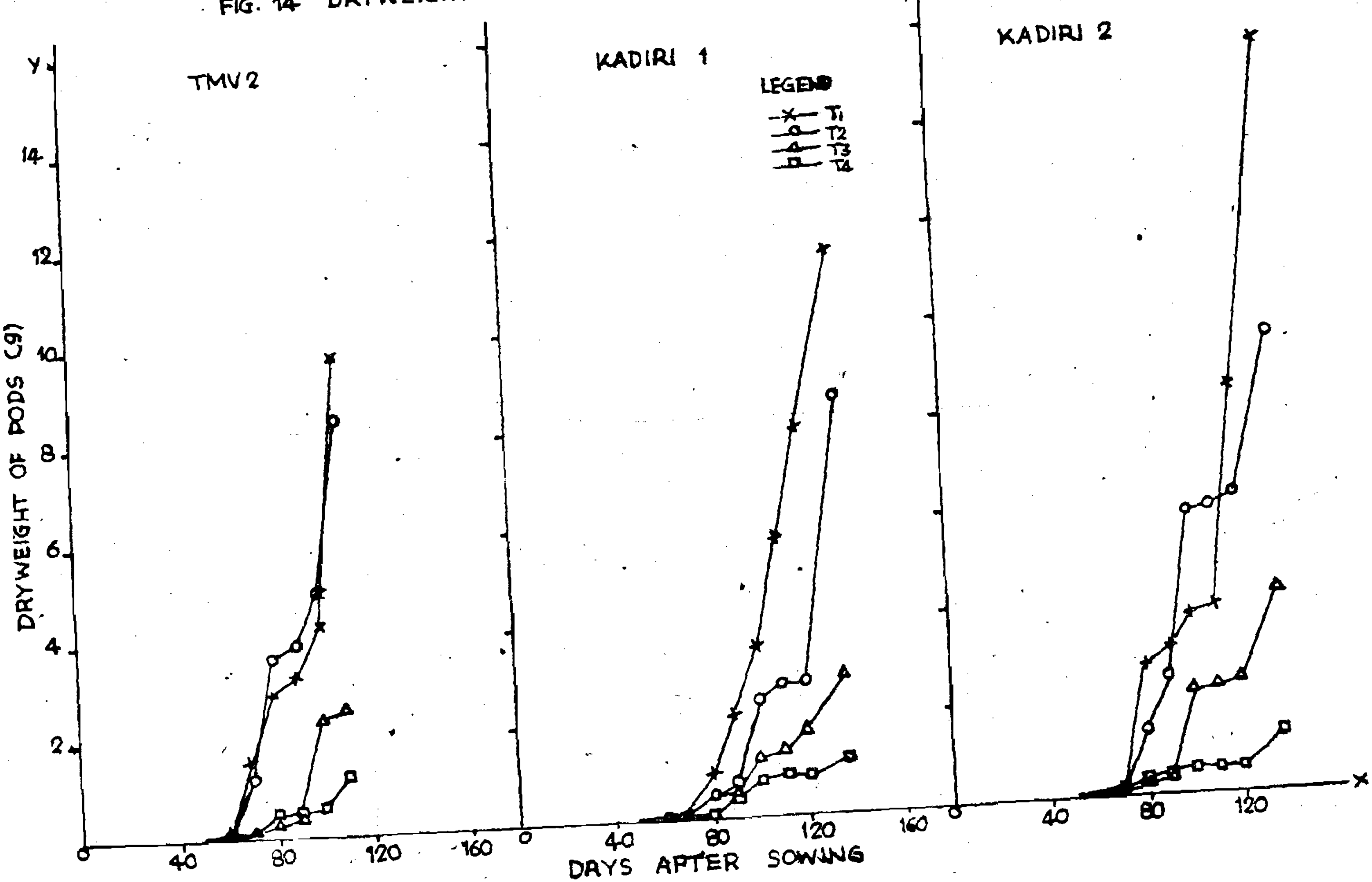
The first treatment of irrigation level recorded maximum pod dry weights and the drop between first and second treatment was only one gram in the case of TMV-2 and it was as high as three grams in Kadiri-1 and six grams in Kadiri-2. The last two treatments in all the cultivars suffered most with lesser quantities of water supply and recorded only four grams (T_3) and one gram (T_4) of dry weight of pod.

The differences between main and sub-treatments and their interactions were statistically significant.

TABLE 15: Dry weight of pods per plant (g)

Treatments	Days after sowing								
	50	60	70	80	90	100	110	120	136
V_1 T_1	0.006	0.027	1.68	2.94	3.34	4.31	9.83		
V_1 T_2	0.035	0.084	1.30	3.77	3.92	5.00	8.54		
V_1 T_3	0	0.010	0.12	0.29	0.44	2.42	2.65		
V_1 T_4	0	0	0.12	0.48	0.47	0.55	1.27		
V_2 T_1	0	0.032	0.21	0.87	2.11	3.45	5.72	7.91	11.52
V_2 T_2	0	0.100	0.17	0.53	0.70	2.35	2.71	2.74	8.53
V_2 T_3	0	0	0.07	0.46	0.49	1.17	1.34	1.69	2.84
V_2 T_4	0	0	0.03	0.07	0.37	0.78	0.79	0.80	1.09
V_3 T_1	0	0.560	0.16	2.70	2.98	3.71	3.77	8.28	15.36
V_3 T_2	0	0.300	0.18	1.31	2.39	5.80	5.94	6.14	9.41
V_3 T_3	0	0	0.12	0.17	0.31	2.16	2.23	2.32	4.09
V_3 T_4	0	0	0.07	0.27	0.36	0.45	0.51	0.55	1.22
C.D. at 5% for									
Treatments		0.007	0.052	0.081	0.090	0.377	0.142	0.223	0.446
Varieties		0.050	0.040	0.050	0.060	0.172	0.137	0.157	0.224
Interactions		0.010	0.081	0.100	0.121	0.344	0.274	0.314	0.448

FIG. 14 DRYWEIGHT OF PODS PER PLANT (g)



4.2.4 Partitioning of dry matter between vegetative and reproductive parts during the crop growth

Total biomass production was taken as 100 at each sampling occasion and relative distribution of biomass into vegetative parts and reproductive parts was worked out in percentage (Table 16 and Fig. 15). Total biomass was accumulated in vegetative parts upto 40 days after sowing in all the cultivars irrespective of treatments. Accumulation of dry matter was noticed appearing in reproductive parts right from 50th day sampling onwards with the first treatments wherein ET/PE ratio was maintained at 1.0. Almost same trend was observed with T_2 treatment of 0.6 ET/PE ratio, in general, in all the cultivars.

In TMV-2, relative proportion of dry matter was accumulated with T_2 treatment right from 80th day in reproductive parts, whereas in T_3 and T_4 treatments less percentage of dry matter was accumulated in reproductive parts.

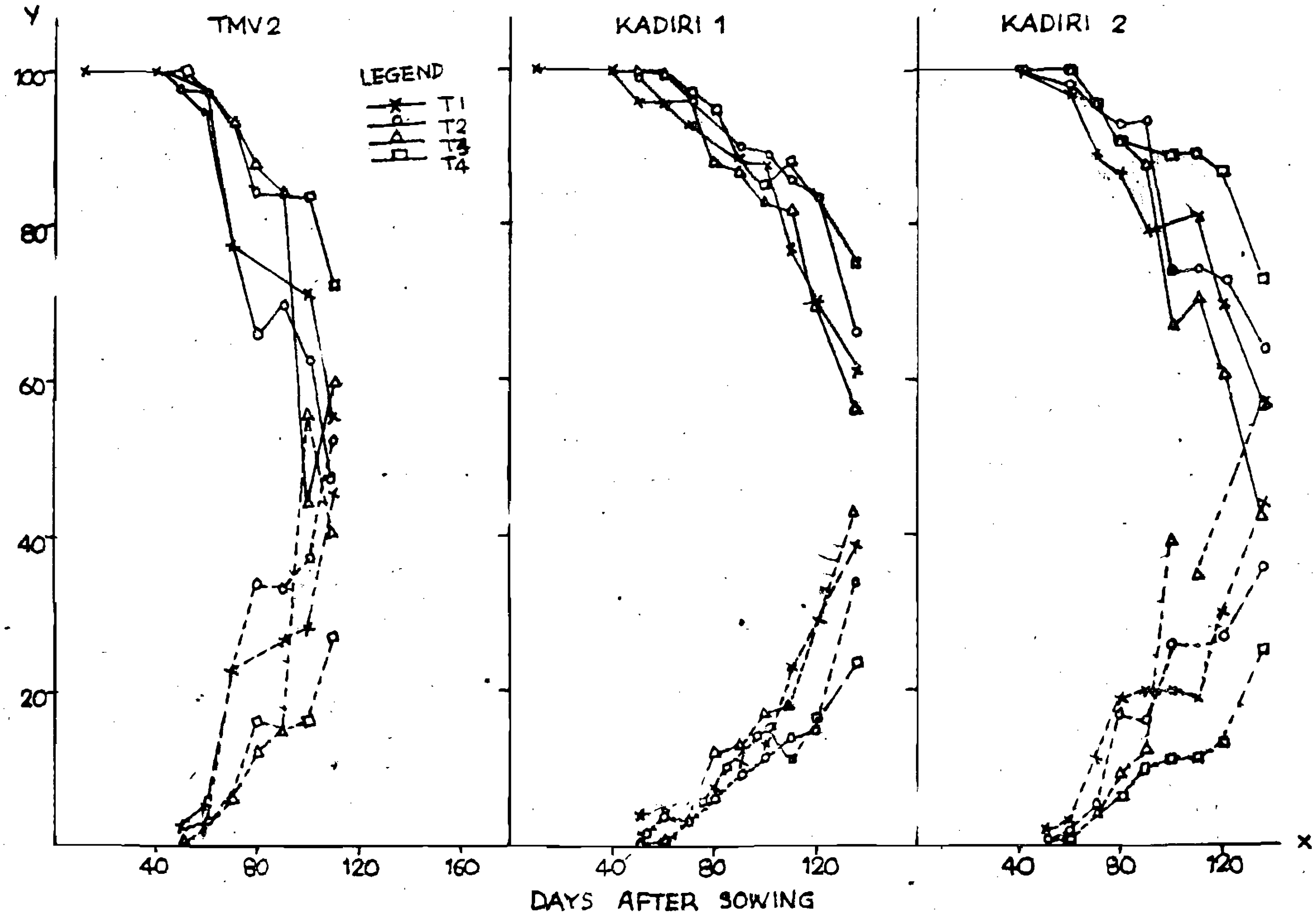
4.2.5 Transpiration

Transpiration rates (Table 17) decreased with decrease in irrigation level upto 0.2 ET/PE ratio. The treatment which did not receive any irrigation showed higher transpiration rates as seen from the data recorded before irrigation. The rate of transpiration recorded immediately after irrigation also exhibited the same trend but comparatively with higher values at corresponding treatment levels. Transpiration rates as varied between

TABLE 16: Dry matter distribution between vegetative and pod components

Treatment		Days after sowing												
		10	20	30	40	50	60	70	80	90	100	110	120	1[illegible]
$V_1 T_1$	Veg	100.0	100.0	100.0	100.0	97.32	94.54	77.41	75.58	73.24	71.36	54.74		
	Rep	0	0	0	0	2.68	5.46	22.59	24.42	26.76	28.64	45.26		
$V_1 T_2$	Veg	100.0	100.0	100.0	100.0	97.53	96.95	76.78	65.80	66.70	62.93	47.40		
	Rep	0	0	0	0	2.47	3.05	23.22	34.20	33.30	37.07	52.60		
$V_1 T_3$	Veg	100.0	100.0	100.0	100.0	99.34	97.75	94.42	87.77	84.45	43.83	60.04		
	Rep	0	0	0	0	0.66	2.25	5.58	12.23	15.55	56.17	39.96		
$V_1 T_4$	Veg	100.0	100.0	100.0	100.0	100.0	98.14	93.05	84.21	84.59	83.68	72.45		
	Rep	0	0	0	0	0	1.86	6.95	15.79	15.41	16.32	27.55		
$V_2 T_1$	Veg	100.0	100.0	100.0	100.0	95.76	94.67	93.45	92.67	88.65	87.04	77.24	70.62	61.[illegible]
	Rep	0	0	0	0	4.24	5.33	6.55	7.33	11.35	12.96	22.76	29.38	38.[illegible]
$V_2 T_2$	Veg	100.0	100.0	100.0	100.0	99.56	95.96	96.36	93.56	90.77	88.64	86.08	84.46	65.[illegible]
	Rep	0	0	0	0	0.44	5.04	3.64	6.44	9.23	11.36	13.92	15.54	34.[illegible]
$V_2 T_3$	Veg	100.0	100.0	100.0	100.0	100.0	99.59	96.01	87.97	86.93	82.78	82.15	68.87	55.[illegible]
	Rep	0	0	0	0	0	0.41	3.99	12.03	13.07	17.22	17.85	31.13	44.[illegible]
$V_2 T_4$	Veg	100.0	100.0	100.0	100.0	100.0	100.0	96.82	92.22	87.92	84.72	88.44	83.68	75.[illegible]
	Rep	0	0	0	0	0	0	3.18	7.78	12.08	15.28	11.56	16.32	24.[illegible]
$V_3 T_1$	Veg	100.0	100.0	100.0	100.0	98.30	97.39	89.22	87.36	79.58	80.25	81.13	70.21	55.[illegible]
	Rep	0	0	0	0	1.70	2.61	10.78	18.95	20.42	19.75	18.87	29.79	44.[illegible]
$V_3 T_2$	Veg	100.0	100.0	100.0	100.0	99.29	97.77	95.17	82.88	83.70	73.87	74.35	73.05	64.[illegible]
	Rep	0	0	0	0	0.71	2.23	4.83	17.12	16.30	26.13	25.65	26.95	36.[illegible]
$V_3 T_3$	Veg	100.0	100.0	100.0	100.0	100.0	100.0	96.37	91.21	87.91	60.49	64.57	54.16	42.[illegible]
	Rep	0	0	0	0	0	0	3.63	8.79	12.09	39.51	35.43	45.84	57.[illegible]
$V_3 T_4$	Veg	100.0	100.0	100.0	100.0	100.0	99.41	95.78	91.62	90.24	88.70	88.18	87.12	73.[illegible]
	Rep	0	0	0	0	0	0.59	4.22	8.38	9.76	11.30	11.82	12.88	26.[illegible]

FIG. 15 PARTITIONING OF DRYMATTER INTO VEGETATIVE AND POD COMPONENTS



V_2 T_1	95.17	25.55	89.31	40.90	64.99	41.40	30.99	76.37	55.70	38.84	48.73	24.24	32.64	43.11
V_2 T_2	89.78	23.15	84.03	25.79	55.13	86.89	26.52	52.18	53.60	19.06	18.69	17.35	24.29	22.54
V_2 T_3	59.95	17.40	48.00	24.94	29.60	29.91	24.26	47.67	17.90	10.54	13.14	13.72	21.79	19.56
V_2 T_4	35.71	27.10	70.15	39.87	58.43	73.10	32.04	56.11	44.54	28.87	18.43	19.52	25.58	33.21
V_3 T_1	59.53	44.65	69.77	47.69	71.29	56.93	29.33	36.68	22.14	22.25	11.72	21.53	56.36	48.89
V_3 T_2	56.63	31.11	68.99	42.98	68.21	41.85	20.37	16.33	20.63	19.06	10.76	12.88	55.45	45.31
V_3 T_3	32.30	18.12	46.57	24.17	33.80	35.10	17.79	16.06	17.45	12.30	8.11	10.98	16.25	15.16
V_3 T_4	76.10	32.67	88.35	20.68	61.53	49.06	24.63	29.60	22.10	38.12	23.92	30.21	34.36	32.85

Days after sowing

	40	50	60	66	73	83	89	97	104	111	122	128
AFTER IRRIGATION												
V_1 T_1	83.59	65.37	40.09	55.06	63.87	68.52	60.65	59.20	70.78			
V_1 T_2	72.75	42.44	37.44	51.28	44.24	39.60	50.90	50.75	39.92			
V_1 T_3	9.33	31.36	9.30	29.93	39.72	31.53	33.95	42.65	37.99			
V_1 T_4	23.91	79.01	36.03	54.28	64.87	77.70	45.45	50.72	39.26			
V_2 T_1	128.46	98.59	26.33	77.44	96.11	107.08	84.11	86.18	79.40	61.22	117.16	82.90
V_2 T_2	113.06	61.49	20.32	66.35	56.98	88.98	72.80	72.89	19.62	48.31	82.95	55.61
V_2 T_3	32.68	51.60	35.58	63.36	46.46	42.02	61.21	67.85	18.17	27.28	44.34	26.72
V_2 T_4	41.99	83.06	42.02	68.37	56.68	58.97	79.35	84.33	35.47	34.26	76.55	64.33
V_3 T_1	154.73	72.10	32.98	98.26	74.90	108.30	83.84	86.77	80.28	42.57	62.04	95.80
V_3 T_2	110.52	51.57	25.11	91.28	69.12	94.80	70.63	55.24	36.00	29.53	61.85	55.95
V_3 T_3	99.44	27.04	20.36	62.30	33.86	26.04	58.54	15.75	21.67	27.40	58.50	51.08
V_3 T_4	101.26	87.34	27.92	84.42	58.92	87.30	70.85	74.21	45.42	35.36	60.88	64.37

TABLE 17: Transpiration at 8-00 A.M. ($mg/dm^2/minute$)

Treatment	Days after sowing													
	10	20	30	57	65	72	82	87	96	103	110	121	127	136
							BEFORE IRRIGATION							
V_1 T_1	45.86	29.76	62.20	36.12	37.86	52.06	27.33	45.23	16.63	36.27	15.99			
V_1 T_2	44.53	25.22	54.84	31.04	31.36	44.41	25.02	27.12	11.44	33.33	14.83			
V_1 T_3	43.86	21.16	48.87	28.75	13.28	34.61	22.54	26.30	9.72	31.05	11.53			
V_1 T_4	54.36	29.94	73.14	45.73	47.62	42.70	28.13	45.21	20.08	32.07	27.95			
V_2 T_1	95.17	25.55	89.31	40.30	64.99	41.40	30.99	76.37	55.70	38.84	48.73	24.24	32.64	43.11
V_2 T_2	89.78	23.15	84.03	25.79	55.13	26.83	26.52	52.18	53.60	19.06	18.69	17.35	24.29	22.54
V_2 T_3	59.95	17.40	48.00	24.94	29.60	29.91	24.26	47.67	17.90	10.54	13.14	13.72	21.79	19.56
V_2 T_4	35.71	27.10	70.15	39.87	58.43	73.10	32.04	56.11	44.54	28.87	18.43	19.52	25.58	33.21
V_3 T_1	59.53	44.65	69.77	47.69	71.29	56.93	29.33	36.68	22.14	22.25	11.72	21.53	56.36	48.89
V_3 T_2	56.63	31.11	68.99	42.98	68.21	41.85	20.37	16.33	20.63	19.06	10.76	12.88	55.45	45.31
V_3 T_3	32.30	18.12	46.57	24.17	33.80	35.10	17.79	16.06	17.45	12.30	8.11	10.98	16.25	15.16
V_3 T_4	76.10	32.67	88.35	20.68	61.53	49.06	24.63	29.60	22.10	38.12	23.92	30.21	34.36	32.85

	Days after sowing											
	40	50	60	66	73	83	89	97	104	111	122	128
						AFTER IRRIGATION						
V_1 T_1	83.59	65.37	40.09	55.06	63.87	68.52	60.65	59.20	70.78			
V_1 T_2	72.75	42.44	37.44	51.28	44.24	39.60	50.90	50.75	39.92			

sampling occasions failed to follow any particular trend op growth.

Soil moisture

e percentage of soil moisture recorded from 3 depths of able 18) indicated that the moisture content in soil was ly increased with depth of soil. More soil moisture was d at a depth of 50-75 cm followed by 25-50 cm and least isture was recorded in upper layers of soil (0-25 cm). isture content just before irrigation was always less mpared to soil moisture recorded immediately after irriga- T_4 recorded lowest soil moisture at all sampling occasions e other treatments. Among the other treatments T_1 recorded il moisture percent followed by T_2 and T_3 at all depths of g. The soil moisture percent did not differ with varieties.

ELD AND YIELD COMPONENTS

Total number of pods per plant

tal number of pods represent both filled and unfilled pods. mber of pods (Table 19 and Fig. 16) was maximum with semi- ng variety followed by spreading and bunch at the time of . Semispreading variety produced more pods per plant than nd spreading cultivars. The difference between spreading ispreading varieties was marginal.

TMV-2 the difference between first irrigation regime to second one was about seven pods. There was a loss of

TABLE 19: Soil moisture (%)

Days after sowing

Treatment		12 B.I	12 P.I	21 B.I	21 P.I	30 B.I	30 P.I	37 B.I	37 P.I	47 B.I	47 P.I	57 B.I	57 P.I	65 B.I	65 P.I
V_1T_1	A	3.47	10.93	6.63	10.87	6.21	10.89	6.19	10.94	6.22	10.81	6.34	10.66	6.35	10.88
	B	4.59	11.03	7.42	11.11	7.18	11.03	7.85	11.28	7.01	11.16	6.99	11.24	6.38	11.12
	C	6.04	11.59	8.18	11.67	8.02	11.62	7.98	11.74	7.76	11.86	7.84	11.92	7.77	11.65
V_1T_2	A	3.66	8.04	5.07	8.06	5.0	8.05	5.02	8.14	5.11	8.22	5.18	8.31	5.11	8.04
	B	4.62	8.64	6.88	8.65	6.59	8.66	6.62	8.78	6.54	8.96	6.58	8.93	6.55	8.65
	C	5.11	9.63	7.01	9.69	6.99	9.65	7.00	9.78	6.97	9.65	7.22	9.72	7.25	9.66
V_1T_3	A	3.32	5.44	4.65	5.51	4.72	5.48	4.68	5.62	4.58	5.55	4.39	5.59	4.33	5.49
	B	4.57	5.32	5.62	5.98	5.84	5.96	5.72	6.04	5.68	5.93	5.58	6.01	5.60	5.38
	C	5.98	5.95	6.37	7.01	6.44	6.93	6.41	7.28	6.11	7.12	6.31	7.29	6.30	6.96
V_1T_4	A	3.24		3.11		2.80		2.67		3.45		3.32		3.56	
	B	4.47		4.21		3.90		3.79		4.54		4.40		4.61	
	C	5.94		6.76		6.32		6.14		7.01		6.83		7.22	
V_2T_1	A	3.52	10.48	6.72	10.52	6.81	10.50	6.77	10.61	6.79	10.56	6.77	10.58	6.72	10.52
	B	4.61	10.65	7.52	10.67	7.62	10.68	7.58	10.94	7.72	10.72	7.64	10.69	7.69	10.70
	C	6.09	11.09	8.08	11.04	8.12	11.05	8.10	11.12	8.22	11.13	8.18	11.14	8.21	11.12
V_2T_2	A	3.49	8.03	5.47	8.01	5.52	8.02	5.51	8.14	5.54	8.10	5.53	8.14	5.55	8.04
	B	4.62	8.57	6.85	8.42	6.91	8.40	6.88	8.66	6.94	8.54	6.79	8.59	6.80	8.39
	C	6.09	10.09	7.22	10.21	7.30	10.19	7.27	10.31	7.36	10.22	7.29	10.27	7.33	10.22
V_2T_3	A	3.51	5.06	4.54	5.07	4.50	5.07	4.52	5.11	4.58	5.08	4.56	5.09	4.59	5.09
	B	4.66	5.54	5.59	5.57	5.26	5.55	5.34	5.62	5.46	5.53	5.40	5.64	5.41	5.57
	C	6.12	7.09	6.27	7.00	6.11	7.05	6.19	7.22	6.22	7.11	6.25	7.15	6.29	7.07
V_2T_4	A	3.45		3.23		2.92		2.62		3.54		3.41		3.59	
	B	4.60		4.34		4.02		3.71		4.32		4.50		4.99	
	C	5.97		6.56		6.35		5.94		7.11		6.93		7.30	
V_3T_1	A	3.71	10.53	6.56	10.72	6.56	10.70	6.84	10.92	6.72	10.84	6.75	10.79	6.71	10.72
	B	4.58	10.96	7.59	10.84	7.74	10.94	7.64	10.99	7.70	10.96	7.68	10.95	7.54	10.95
	C	6.17	11.48	8.21	11.32	8.32	11.35	8.28	11.44	8.29	11.35	8.34	11.29	8.41	11.28
V_3T_2	A	3.55	8.37	5.52	8.41	5.54	8.39	5.72	8.52	5.62	8.41	5.65	8.39	5.66	8.41
	B	4.59	9.12	6.80	9.22	6.92	9.16	6.85	9.54	6.90	9.35	6.88	9.29	6.86	9.18
	C	6.11	10.33	7.76	10.11	7.84	10.50	7.80	10.36	7.81	10.42	7.92	10.27	7.99	10.42
V_3T_3	A	3.49	5.53	4.51	5.57	4.54	5.55	4.62	5.62	4.60	5.53	4.54	5.61	4.50	5.57
	B	4.57	5.19	5.59	6.21	5.62	6.20	5.71	5.41	5.65	6.31	5.61	6.42	5.60	6.23
	C	6.09	6.93	6.30	5.94	6.48	6.36	5.51	7.00	6.56	5.98	6.49	6.95	6.55	6.90
V_3T_4	A	3.43		3.21		2.91		2.57		3.62		3.49		3.60	
	B	4.59		4.38		4.02		3.79		4.72		4.56		4.78	
	C	6.95		6.51		6.28		5.84		7.08		6.88		7.18	

Treatment		72 B.I	72 P.I	82 B.I	82 P.I	88 B.I	88 P.I	96 B.I	96 P.I	103 B.I	103 P.I	110 B.I	110 P.I	115 B.I	115 P.I	121 B.I	121 P.I	127 B.I	127 P.I	136 B.I
V_1T_1	A	6.24	10.38	6.01	10.69	6.28	10.89	6.95	10.74	6.34	10.35	6.25	10.69							
	B	7.00	11.25	6.77	11.25	6.81	11.14	7.54	11.12	6.82	11.09	7.02	11.28							
	C	7.95	11.94	7.54	11.90	7.59	11.67	8.01	11.58	7.61	11.59	7.98	11.94							
V_1T_2	A	5.00	8.24	4.55	8.30	4.57	8.67	5.02	8.55	4.62	8.01	5.04	8.31							
	B	6.65	8.91	6.32	8.95	6.39	8.72	6.88	8.70	6.41	8.63	6.68	8.99							
	C	7.01	9.63	6.73	9.65	6.79	9.71	7.24	9.70	6.83	9.54	7.04	9.64							
V_1T_3	A	4.69	5.53	4.42	5.60	4.45	5.87	4.32	5.74	4.54	5.37	4.72	5.61							
	B	5.75	5.95	5.51	6.04	5.52	5.95	6.04	5.86	5.56	5.96	5.78	6.06							
	C	6.45	7.10	6.28	7.32	6.29	6.98	6.77	6.85	6.32	6.92	6.50	7.35							
V_1T_4	A	3.32		3.15		2.88		4.01		3.82		3.61								
	B	4.46		4.32		4.05		5.06		4.91		4.54								
	C	7.01		6.90		6.69		7.35		7.23		6.84								
V_2T_1	A	6.78	10.61	6.76	10.72	6.78	10.64	7.42	10.58	6.81	10.71	6.80	10.77	6.78	10.63	6.75	10.72	6.55	10.79	5.53
	B	7.59	10.75	7.70	10.89	7.74	10.72	8.45	10.65	7.82	10.92	7.60	10.92	7.72	10.93	7.71	10.90	7.67	10.94	7.32
	C	8.14	11.19	8.21	11.22	8.25	11.14	8.94	11.08	8.29	11.25	8.16	11.25	8.27	11.15	8.29	11.23	8.21	11.23	[illegible]
V_2T_2	A	5.52	8.12	5.55	8.22	5.56	8.26	5.98	8.19	5.62	8.25	5.54	8.20	5.58	8.15	5.60	8.21	5.57	8.25	5.32
	B	6.89	8.59	6.87	8.63	6.99	8.41	7.52	8.38	7.01	8.65	6.88	8.61	6.94	8.67	6.95	8.63	[illegible]	8.65	[illegible]
	C	7.29	10.24	7.28	10.29	7.42	10.28	7.38	10.26	7.53	10.32	7.31	10.27	7.45	10.33	7.50	10.29	7.42	10.29	[illegible]
V_2T_3	A	4.54	5.11	4.59	5.19	4.59	5.31	5.02	5.11	4.62	5.21	4.55	5.17	4.61	5.15	4.65	5.19	4.59	5.29	[illegible]
	B	5.35	5.62	5.52	5.69	5.50	6.63	6.04	5.55	5.64	5.72	5.36	5.65	5.52	5.64	5.53	5.67	[illegible]	[illegible]	[illegible]
	C	6.20	7.13	6.33	7.15	6.25	7.11	6.76	7.08	6.54	7.13	6.25	7.14	6.27	7.24	6.29	7.17	[illegible]	7.24	[illegible]
V_2T_4	A	3.35		3.22		2.94		4.04		3.85		3.64		3.25		3.06		2.79		[illegible]
	B	4.77		4.56		4.25		4.94		4.80		4.34		4.21		4.06		3.34		[illegible]
	C	7.17		7.04		6.76		7.42		7.30		6.35		6.54		6.21		5.31		[illegible]
V_3T_1	A	6.85	10.85	6.77	10.84	6.75	10.89	7.41	10.75	6.78	10.86	6.75	10.82	6.77	10.90	6.79	10.84	[illegible]	10.91	[illegible]
	B	7.65	10.92	7.69	10.90	7.69	10.92	8.32	10.88	7.72	10.88	7.70	10.94	7.69	[illegible]	7.75	[illegible]	[illegible]	[illegible]	[illegible]
	C	8.30	11.28	8.31	11.19	8.33	11.19	8.94	11.15	8.45	11.21	8.34	11.22	8.32	[illegible]	[illegible]	11.25	8.57	11.25	[illegible]
V_3T_2	A	5.77	8.52	5.62	8.51	5.66	8.61	6.12	8.55	5.72	8.57	5.55	8.52	5.56	8.54	5.67	8.54	5.53	[illegible]	5.31
	B	6.89	9.39	6.82	9.35	6.93	9.31	7.44	9.25	7.12	9.37	6.64	9.37	6.83	9.57	6.92	9.39	[illegible]	[illegible]	6.52
	C	7.88	10.45	7.85	10.40	7.93	10.24	8.61	10.15	8.11	10.42	7.89	10.43	7.94	10.12	7.37	10.47	7.91	10.47	7.54
V_3T_3	A	4.65	5.56	4.51	5.45	4.55	5.94	5.02	5.86	4.58	5.52	4.54	5.43	4.53	5.55	4.52	[illegible]	4.59	5.47	4.32
	B	5.75	6.38	5.52	6.29	5.67	6.35	6.25	6.30	5.72	6.37	5.53	6.31	5.64	6.47	5.76	[illegible]	5.59	[illegible]	[illegible]
	C	6.71	6.35	6.37	6.92	6.52	6.89	7.22	6.79	6.53	6.95	6.39	6.33	5.52	7.38	6.54	[illegible]	5.41	5.07	5.12
V_3T_4	A	3.35		3.19		2.89		3.96		3.74		3.52		3.51		3.06		2.77		2.51
	B	4.63		4.42		4.18		4.85		4.58		4.35		4.22		[illegible]		3.35		3.60
	C	6.38		6.81		6.65		7.39		7.20		6.81		6.54		6.15		[illegible]		5.20

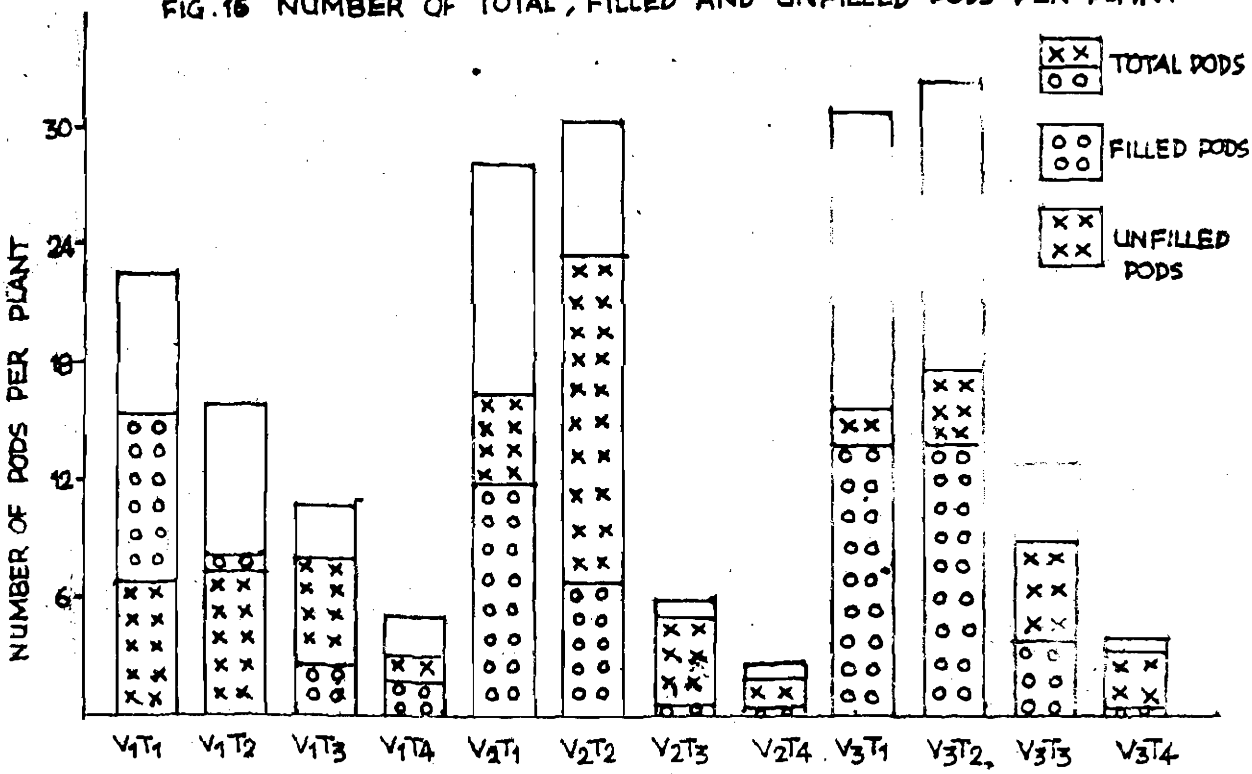
B.I = Before irrigation P.I = Post irrigation

A = 0–25 cm. B = 25–50 cm. C = 50–75 cm.

TABLE 19: Table showing yield and yield components.

Treatment	No. of total pods/ plant	No. of filled pods/ plant	No. of unfilled pods/ plant	Test weight (g)	Shelling percentage	Pod yield (kg/ha)	Haulm yield (kg/ha)	Harvest index	Water use efficiency (pods in kg/mm of water used)
$V_1 T_1$	22.54	15.47	7.07	25.40	65.76	1766.13	3063.52	0.37	2.49
$V_1 T_2$	15.73	8.20	7.53	23.60	67.15	1201.03	2083.68	0.38	2.79
$V_1 T_3$	10.73	2.60	8.13	16.27	45.32	378.57	1815.67	0.18	2.52
$V_1 T_4$	4.87	1.80	3.07	12.43	37.34	177.53	899.02	0.16	-
$V_2 T_1$	28.27	11.87	16.40	28.53	59.82	2342.60	3323.61	0.41	2.89
$V_2 T_2$	30.33	6.93	23.40	26.06	61.12	2036.57	2563.72	0.44	4.15
$V_2 T_3$	5.87	0.60	5.27	21.94	53.01	577.54	1923.66	0.23	3.39
$V_2 T_4$	2.47	0.40	2.07	17.70	40.10	228.58	948.93	0.19	-
$V_3 T_1$	30.74	14.67	16.07	37.27	65.16	2894.53	3869.61	0.43	3.57
$V_3 T_2$	32.14	14.47	17.67	34.60	59.88	2673.67	3284.47	0.45	5.45
$V_3 T_3$	12.80	3.80	9.00	29.83	54.75	754.62	2243.60	0.25	4.43
$V_3 T_4$	4.00	0.40	3.60	19.62	41.80	320.64	1183.34	0.21	-
C.D. at 5% for									
Treatments	0.740	0.341	0.540	1.510		152.23	369.38		
Varieties	0.669	0.644	0.563	1.010	-	94.98	224.30		
Interactions	1.336	1.290	1.130	2.020		189.96	448.60		

FIG. 16 NUMBER OF TOTAL, FILLED AND UNFILLED PODS PER PLANT



five more pods with next stress treatment (T_3) and a further loss of six pods was observed with zero irrigation treatment.

In Kadiri-1 maximum number of pods was realised with second moisture regime treatment (T_2) followed by T_1, T_3 and T_4. The difference between first two regimes was marginal, whereas, there was a loss of 25 pods with the next stress treatment (T_3) and only two pods were realised with no irrigation treatment (T_4). Almost similar trend was observed in the case of semispreading cultivar. In summary, the second moisture regime (T_2) fared well than first moisture regime in the case of spreading and semispreading varieties whereas in bunch cultivar maximum yields were obtained with the treatment in which maximum water was added.

The differences between main and sub-treatments and their interactions were statistically significant.

4.3.2 <u>Number of filled pods per plant</u>

Number of filled pods was maximum (Table 19 and Fig. 16) with TMV-2 followed by Kadiri-2 and Kadiri-1. Under normal irrigation TMV-2 produced about 15 filled pods followed by Kadiri-2 (14.6) and Kadiri-1 (12.0). The number of filled pods was not affected by lowering the moisture regime from 1.0 to 0.6 in the case of Kadiri-2. The other two varieties, Kadiri-1 and TMV-2 registered a 50 per cent fall in the production of filled pods from first irrigation regime to second irrigation regime. In all the cultivars filled pods got reduced with decrease in soil moisture regime except Kadiri-2 at second irrigation level.

The differences between main and sub-treatments and their interactions were statistically significant.

4.3.3 Number of pops (unfilled pods)

The data on number of pops (Table 19 and Fig. 16) indicated that maximum number of unfilled pods were recorded by Kadiri-1 followed by Kadiri-2 and TMV-2 at first two moisture regimes. Among the first two moisture regimes (T_1 and T_2) the number of pops were more with second moisture regime. The extreme soil moisture regimes recorded less number of pops and the magnitude of such reduction was proportional to the stress applied within the range of last two moisture regimes. The differences between various treatments and their interactions were significant.

4.3.4 Test weight (g/100 kernels)

Maximum kernel weight (Table 19 and Fig. 17) was recorded by Kadiri-2 followed by Kadiri-1 and TMV-2. The decrease in irrigation regimes had a profound negative effect on test weight. Test weight gradually decreased with reduction in quantum of water supplied in respective treatments.

4.3.5 Shelling percentage

The shelling percentage (Table 19 and Fig. 17) was maximum with T_2 in TMV-2 and Kadiri-1 and with T_1 in the case of Kadiri-2. The other two extreme stress treatments reduced the shelling percentage as the magnitude of stress increased.

FIG. 17.1 TEST WEIGHT

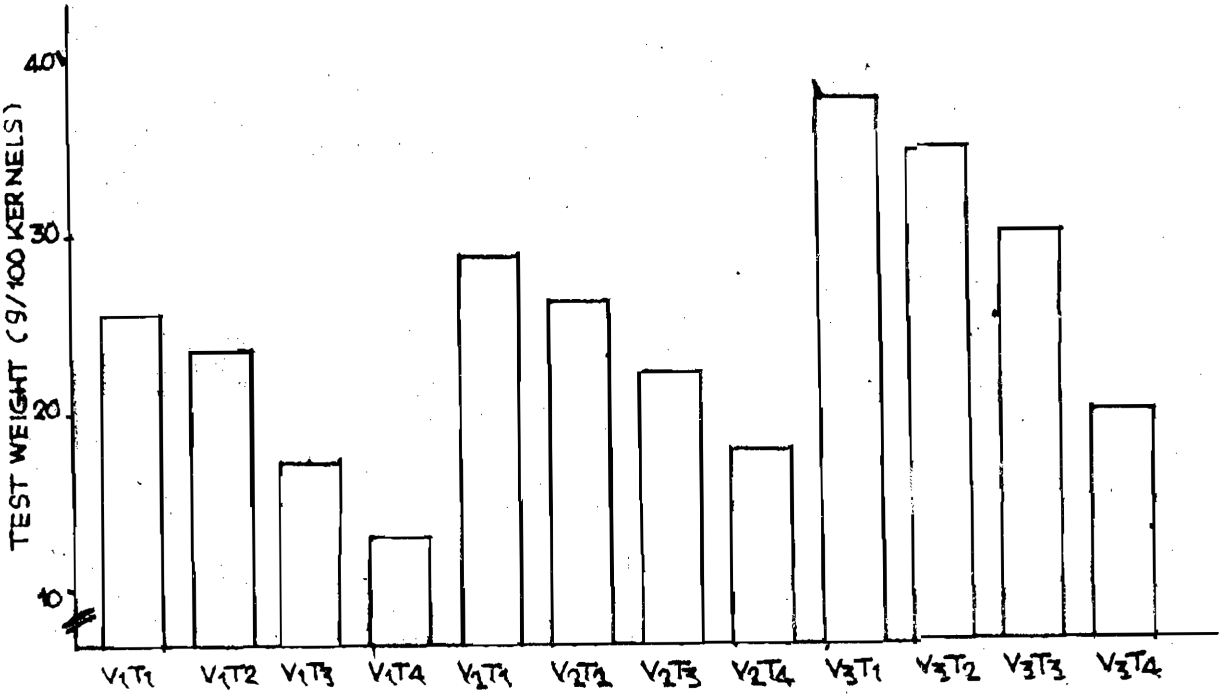
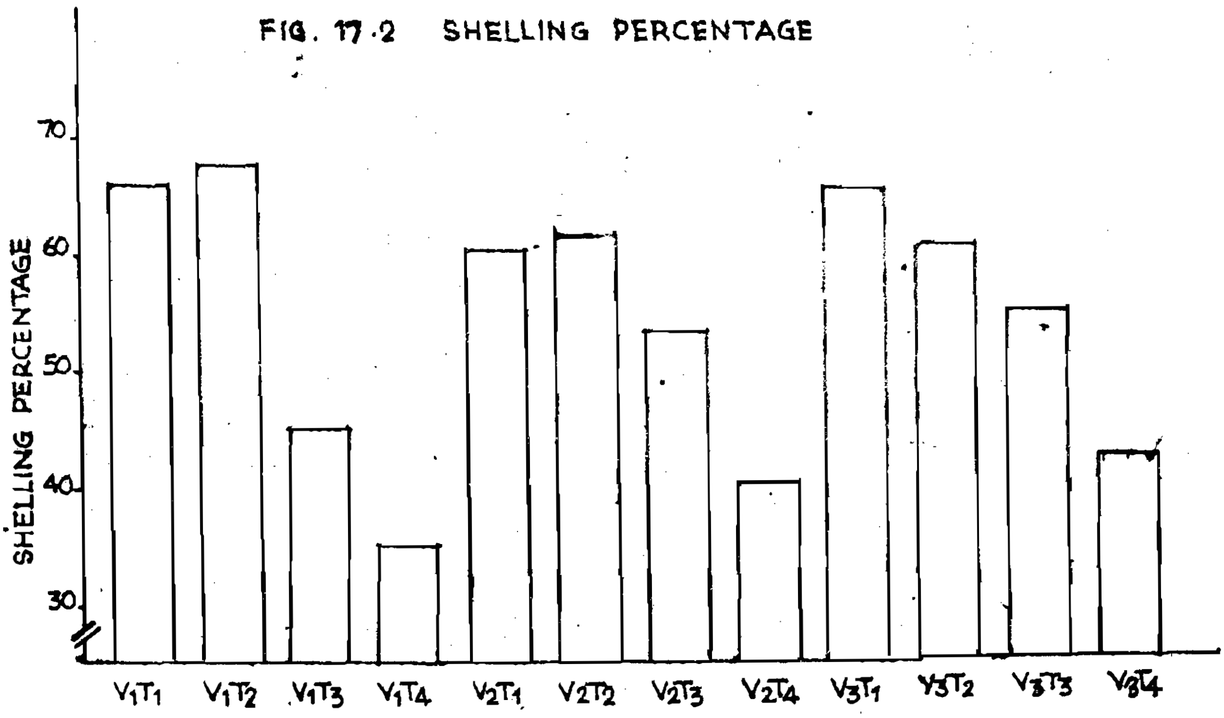


FIG. 17.2 SHELLING PERCENTAGE



4.3.6 Pod yield (kg/ha)

The pod yield per hectare were computed from the yields obtained from various treatmental plots and presented in Table 19 and graphically represented in Fig. 18. Maximum pod yields were recorded by Kadiri-2 followed by Kadiri-1 and TMV-2 at a maximum irrigation schedule with ET/PE ratio of 1.0. In all the varieties there was a reduction in yield with lowering of quantum of irrigation water at the respective treatments.

In TMV-2 there was a reduction of five quintals by reducing the quantity of irrigation water from 1.0 ET/PE ratio to 0.6. Further reduction in quantity of irrigation resulted in significant reduction in yield and yields recorded by last two treatments were almost nominal. In the case of Kadiri-1 there was a reduction of three quintals of pod yield with lowering the ET/PE ratio from 1.0 to 0.6. The other two treatments with an irrigation schedule equivalent to less than ET/PE ratio of 0.6 registered nominal pod yield. Similarly, in the case of Kadiri-2 there was decrease in pod yield by curtailing quantum of water given to various other treatments compared to an irrigation schedule equivalent to 1.0 ET/PE ratio.

The magnitude of reduction between first two treatments was maximum in the case of TMV-2 followed by Kadiri-1 and Kadiri-2.

The differences between main and sub-treatments and their interactions were statistically significant.

FIG. 18.1 POD YIELD (Kg/ha)

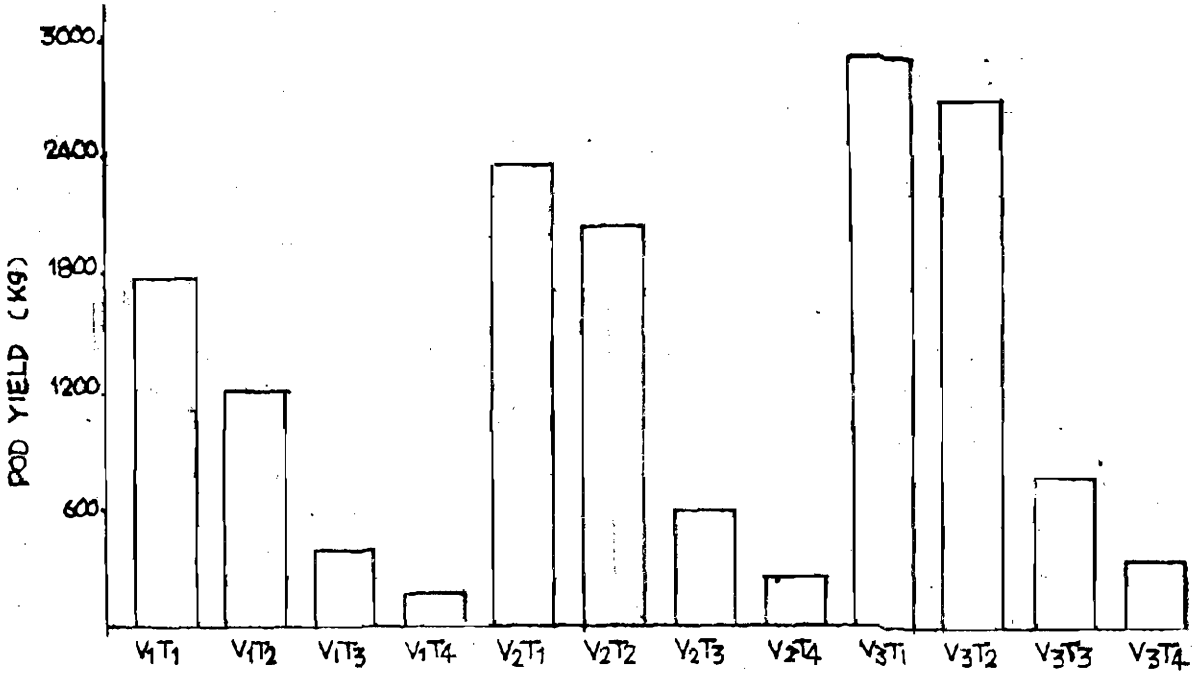
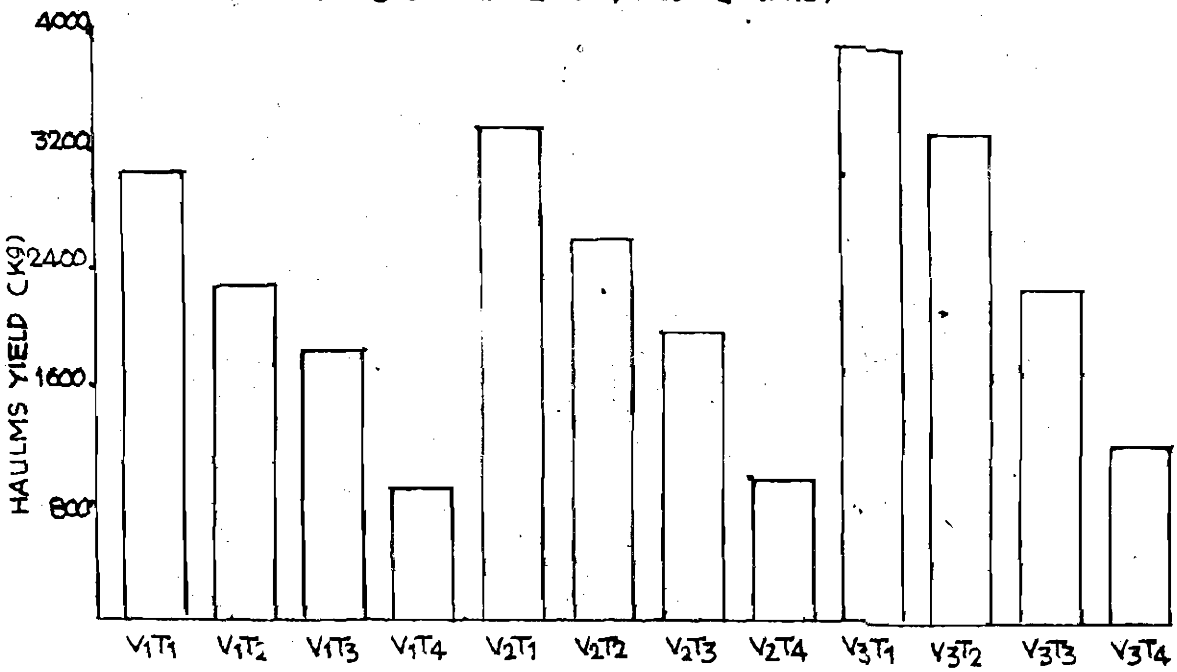


FIG. 18.2 HAULMS YIELD (Kg/ha)



4.3.7 Haulms yield (kg/ha)

Haulms yield was computed per hectare from the data obtained from the plot yields of respective treatments and presented in Table 19 and plotted in Fig. 18. Maximum haulm yields was recorded by Kadiri-2 followed by Kadiri-1 and TMV-2 with a highest irrigation schedule given at a ratio of 1.0 of ET/PE. In all the cultivars there was a reduction in haulms yield with decreasing the irrigation from ET/PE ratio of 1.0 and such decline was gradual from ET/PE ratio of 1.0 to 0.6 and the reduction was drastic beyond 0.6 of ET/PE ratio.

In TMV-2 there was a reduction of about 10 quintals by dropping the irrigation from 1.0 to 0.6 ET/PE ratio and further reduction in irrigation level drastically reduced the haulms yield. Similarly there was a reduction of about eight quintals in Kadiri-1 and six quintals in Kadiri-2 when irrigation was dropped from 1.0 to 0.6 ET/PE ratio. Further reduction in quantity of irrigation applied resulted in drastic reduction of haulm yields.

The reduction in haulm yields with stress treatments (decreasing the ET/PE ratio) was maximum with TMV-2 followed by Kadiri-1 and Kadiri-2.

The differences between main and sub-treatments and their interactions were statistically significant.

4.3.8 Harvest index

The data on harvest index are presented in Table 19. Maximum harvest index was observed with Kadiri-2 in T_1 treatment followed by T_2 treatments of Kadiri-1 and TMV-2. The first two moisture regimes with available soil moisture maintained with an irrigation schedule equivalent to ET/PE ratio of 1.0 to 0.6 registered higher harvest indices in all cultivars and less than these soil moisture regime registered lower harvest indices. There was a drop of about 30 per cent in harvest index when irrigation schedule was dropped from 0.6 to 0.2 of ET/PE ratio. Thus, irrigation schedules have direct bearing on the harvest index.

4.3.9 Water use efficiency

In all the varieties maximum water use efficiency was observed with T_2 followed by T_3 and T_1. As T_4 did not receive any irrigation, the values of water use efficiency were not presented in the Table 19. Of the three varieties, maximum values of water use efficiency were recorded by Kadiri-2 at any level of irrigation followed by Kadiri-1 and TMV-2.

V DISCUSSION AND CONCLUSION

Rabi groundnut crop is grown mostly under assured irrigation systems and farmers schedule the irrigation based on their own experience gained over years in the absence of precise technical data at their hand without giving due weightage to the variety that they are growing and under such situations a scientific approach in scheduling the irrigations for different varieties is of paramount importance. It is against this background, the present investigation was aimed at to precisely point out the influence of quantity of water applied on the morphological, physiological and yield characters. Attempt was also made to critically view the data obtained and presented in results chapter and discussed the same in the following paragraphs in the light of available literature. As the experimental material drawn from three distinct botanical groups, their growth behaviour was also summarised duly comparing each other and as influenced by the quantity of irrigation water supplied under various irrigation treatments.

5.1 GROWTH PARAMETERS

The initial slow growth, a lag phase, was extended upto 40 days in the case of bunch groundnut and upto 50 days in the other two long duration cultivars. The influence of moisture stress on rate of increase in plant height was felt more during the lag phase of the crop growth. This stage thus possibly represents rapid cell elongation in the region of internodes and stress treatments decreased such elongation. Moisture stress was known to reduce the rate of cell division and cell enlargement (Kirkham *et al*., 1971; Bidinger, 1978). The results indicated that the reduction in plant height was directly proportional to the quantity of stress imposed. Reduction in plant height with moisture stress was reported by Tamala Reddy (1974) and Subhash Babu (1977) in groundnut and Ali and Alam (1973) in green gram.

The two primary branches produced by 10th day arose from the axils of two cotyledons even at the embryonic stage in all the cultivars. At the later stages of crop growth the difference between the irrigations received at a ratio of 1.0 and 0.6 were marginal and further reduction in quantity of water supplied reduced the primary branches drastically. As the primary branches were main source for the production of pods, the reduction in yield obtained in the experiment might be due to the reduction in primary branches. It appears from the data that the milder stress did not effect this character whereas severe stress did. More number of primary branches were observed with spreading and semi spreading cultivars. In tillering or branching crops, water deficits reduce tillering and branching (Rackham, 1972; Quarrie and Jones, 1977).

5.2. PHYSIOLOGICAL PARAMETERS

Both leaf number and leaf area gradually increased till harvest in TMV-2 without any symptoms of senescence or leaf fall. The leaf fall observed in the kharif in the case of

TMV-2 was possibly due to prevalence of fungal diseases, which develop with low temperatures and high relative humidity coupled with cloudy weather whereas in rabi high temperatures, low relative humidity prevail with high radiation. The leaf number and area gradually increased and peaked at 100-110 days with a leaf fall during the subsequent stages of crop growth in all the treatments in Kadiri-1 and Kadiri-2. More leaf number and leaf area were observed with spreading and semi spreading cultivars than bunch cultivar. The bunch cultivar generally exhibit larger individual leaf areas in comparison with spreading ones. However, the LAI was greater in Kadiri-2 followed by Kadiri-1 and TMV-2 which apparently is more of a function of the leaf number rather than individual leaf area.

The values of both the leaf area and leaf number were marginally decreased with milder stress (T_2) and drastically lowered with last two severe stress treatments. The decrease in leaf area was more than the reduction in leaf number with various treatments. In brief it may be mentioned that both these parameters may be effected by stress; the values of leaf area index suffered most. The reduction in these two parameters reduces the photosynthetic area which reflects ultimately on the yielding ability of the plant. The reduction in leaf area in green gram was reported by Ali and Alam (1973) and in soybean (Huck et al., 1981). Huck et al. (1981) further pointed out that leaf number unaltered with the stress whereas leaf area index reduced drastically and similar findings were reported by Singh and Rajendra Prasad (1980).

Groundnut is known to be drought tolerant and several mechanisms may be operating singly or in combination to reduce the water loss from the plant. One of the strategies for reducing water loss by the crop plants is to reduce the evaporative surfaces. Since crop evaporation is lenierly related to leaf area until complete ground cover (Ritchie, 1974), a reduction in leaf area to below threshold levels will reduce water loss. Leaf expansion is known to be very sensitive to water deficits in some species (Boyer, 1970; Hsiao et al., 1970; Acevedo et al., 1971) and even short periods of water stress in the vegetative phase can have permanent effects and the final leaf area accumulated by crops (Boyer, 1970; Acevedo et al., 1971; Ludlow and Ng, 1977). The second mechanism operating in groundnut is the reduction in radiation intercepted and this is achieved by active and passive leaf movements. In the present experiment mid-day closure of leaflet was observed for the avoidance of radiation load. When the water supply is adequate the leaves follow the sun and are perpendicular to the incident radiation but as water deficit develops the plant orientates its leaves parallel to incident radiation. Similar parahelionastic leaf movements have been shown in bean (Dubetz, 1969). Leaves of crops frequently roll or hang limp when stressed. This passive leaf movement reduces the interception of radiation (Begg and Turner, 1976) and thereby counteracting increase in leaf temperature arising from stomatal closure (Gates, 1968) and preventing further development of leaf water deficits.

The transpiration rates were lower with decrease in the quantity of irrigation water given. The extreme stress (T_4) enhanced the transpiration values. The milder stress treatments regulate the transpiration rates with the closure of stomata. Such leaf diffusion resistance due to water loss was also reported by Pallas et al. (1979). The transpiration rates were revived immediately after irrigation as seen from Table 17. Much of the plant water stress that developed during drought was relieved the day after irrigation and leaf diffusion resistances also returned to near normal. One of the physiological mechanisms involved in reduction of transpiration is the stomatal control. Crop plants show a range in sensitivity of the stomata to water deficits. Turner (1974a) and Turner and Begg (1975) showed that under field conditions stomata close at leaf water potential ranging from -8 bars in field beans to about -28 bars in cotton. The closure of stomata depends on stress history of the plant (Mc Cree, 1974; Brown et al., 1976; Thomas et al., 1976; Turner et al., 1978b).

In general, there was a reduction in number of flowers, pegs and pods with decrease in quantity of irrigation water given to various treatments except in T_2 of spreading and semi spreading cultivars in respect of pegs and pods in which the peg and pod number were more. Such reduction in number of pegs with stress was observed by Lee et al. (1972), Khan (1979) and Williams and Nageswara Rao (1981) in groundnuts. The increase in number of pegs and pods observed with an irrigation level of 0.6 ET/PE ratio in Kadiri-1 and Kadiri-2 clearly indicates lesser water requirement by Kadiri-1 and Kadiri-2 than TMV-2. The reduction in pod number with stress treatments is in agreement with several earlier reports (Radder et al., 1969; Mohan, 1971; Williams and Nageswara Rao, 1981). It is recognised in groundnuts that the production of flower ceases when irrigation becomes due and it resumes and attains a peak subsequent to irrigation. Cycles of above process are common. In the present study, flower production did not cease in early phase of flower production at 1.0 of ET/PE ratio. The above mentioned situation was observed in the later phase. These observations are partially in agreement with the findings of Williams and Nageswara Rao (1981) who observed increased flower production with sudden release of plants from stress with irrigation but their observations are general in nature but not specific to any stage.

There was a gradual increase in root dry weight right from sowing and peaked at 80 days in TMV-2 and 90 days in other two cultivars and declined thereafter. Similarly Reddy et al. (1978-80) obtained maximum root dry weights around 75-90 days in some groundnut cultivars.

Maximum stem dry weights were observed around 80 days in TMV-2, 100 days in Kadiri-1 and 110 days in Kadiri-2. A critical examination of the data between pod development accumulation of dry weight in stems indicates a rapid accumulation of photosynthates prior to pod development in stems. Such increase in stem dry weight during pre-anthesis period was reported by Stoy (1965) in wheat and Rao (1974) in bajra. These authors emphasized the importance of those temporarily stored sugars for the grain development during the periods of acute demand and reduced photosynthate supply especially under drought situation. As observed in the case of bajra by ^{14}C technique (Rao and Singh, 1980; Rao et al., 1977) stem reserves were noted to be remobilised to grains and stem biomass declined as grain maturity progressed.

The accumulation of dry matter in leaves and decline was intune with the leaf area expansion. The reduction in dry matter from the first to the second level of irrigation was not marked whereas such reduction was as high as ten per cent between the last two levels of irrigation.

The dry weight of pegs decreased with severe stress treatments. The reduction in dry weight of pegs is relatable to the number of pegs produced which again depends on the flower production and the data from flower production lends support to the findings of Reddy et al. (1978-80).

Maximum rate of dry matter accumulation in pods was observed ten days prior to harvest in TMV-2 and 20 days in other two

TABLE 20: Partitioning of photosynthates to various plant parts at the time of harvest

Treatment	Total dry matter (g)	% partitioning in various plant parts				
		Stem	Petiole	Leaf	Peg	Pod
V_1 T_1	22.44	20.86	2.58	31.29	1.47	43.79
V_1 T_2	17.13	13.19	4.20	30.00	2.74	49.86
V_1 T_3	6.59	10.62	3.37	44.63	1.17	40.21
V_1 T_4	4.87	19.17	4.58	48.69	1.44	26.11
V_2 T_1	31.85	24.26	3.54	33.50	2.51	36.18
V_2 T_2	27.07	27.08	4.92	33.76	2.73	31.50
V_2 T_3	6.66	21.32	5.12	29.43	1.50	42.63
V_2 T_4	4.44	28.54	6.85	40.10	0	24.51
V_3 T_1	37.88	21.26	3.94	30.38	3.85	40.56
V_3 T_2	29.39	25.63	4.35	34.34	3.64	32.03
V_3 T_3	7.16	13.50	3.41	25.55	0.42	57.11
V_3 T_4	4.57	30.75	4.44	38.25	0	26.56

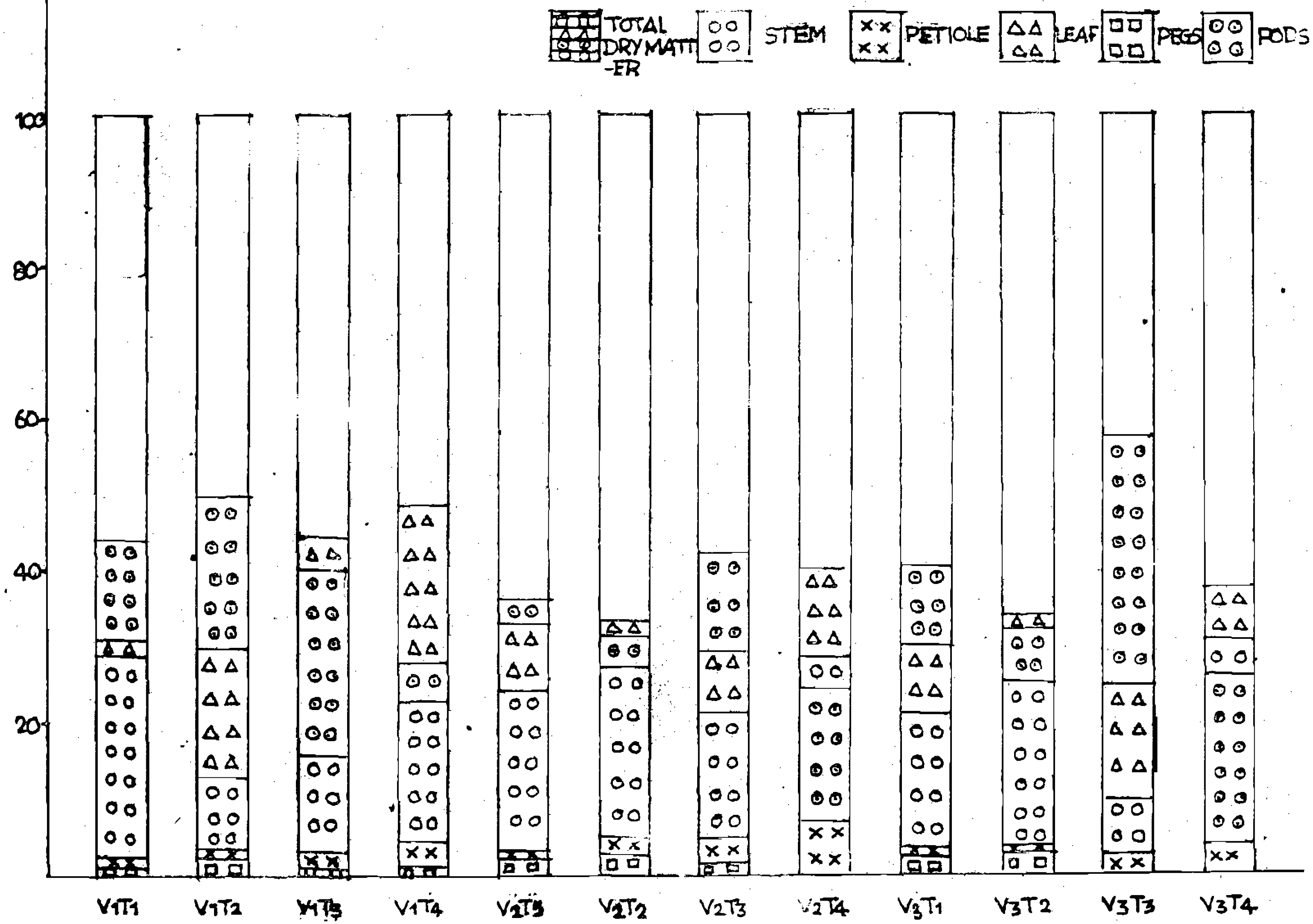
cultivars. This period approximately coincides with the decline in stem dry weights. This suggests a remobilisation of stem reserves to the pods development and relatively more partitioning of photosynthates towards pod development since all the other sinks are in the phase of senescence. Maximum dry matter in pods was found in spreading and semi spreading cultivars than in TMV-2 and this indicates higher yield potential of spreading and semi spreading cultivars than TMV-2. Severe stress treatments reduced the dry weight of pods.

Dry weight of all parts of plant at the time of harvest was pooled and considered it as 100 and percentage distribution in various parts of the plant was worked and presented in Table 20 and Fig. 19. In general, dry matter accumulation was least in pegs followed by petioles. The major portion of the dry matter was accumulated either in pods or leaves or stems. Such relative distribution among these three organs varied between various treatments and such variation was also influenced by the varieties.

The treatment which received irrigation equivalent to ET/PE of 1.0 resulted in more accumulation of dry matter in pods followed by leaves and stems which indicated effective translocation of photosynthates from stem to pod. Incidentally, this treatment also registered maximum yields over the other treatments.

A clearcut influence of various treatments on the dry matter distribution of various plant parts was not evident across the

FIG. 19 PARTITIONING OF PHOTOSYNTHATES TO V US PLANT PARTS AT THE TIME OF HARVEST



varieties. This suggests that severe stress treatments reduced both the source size and sink size. The decrease in source size with stress treatments was evident from the data on LAI. Added to the reduction in source size, its activity also must have been reduced with stress treatments and therefore source size and its activity was curtailed. Similarly stress treatments reduced the sink size by cutting down the daily flower production. Therefore reduction in yield is accountable to the reduction in both source and sink size.

5.3 YIELD AND YIELD COMPONENTS

All stress treatments reduced the number of filled pods in all the cultivars except Kadiri-2 at second irrigation level. These results are in consistent with general experience that spreading and semi spreading cultivars are more tolerant to reduced moisture supply. The water requirement for pod production was found to be less in the case of spreading and semi spreading varieties than bunch cultivar.

At milder stress regime more number of pops were produced with decrease in soil moisture regime from 1.0 to 0.6 ET/PE ratio whereas soil moisture applied at rates less than 0.6 ET/PE ratio drastically reduced even the pops. The data thus indicated that either increase in number of pops at lower soil moisture regime than required and decrease in pops with increase in

The treatments less than 0.6 ET/PE ratio reduced the yields drastically and registered only nominal yields. For realising optimum yields, the optimum ratio between irrigation water and cumulative pan evaporation was found to be between 0.9 to 0.6 (Subramanian et al., 1974), 1.0 (Subhash Babu *et al.*, 1977; Dahatonde, 1978; Ingle, 1979) and 0.75 (Khan and Datta, 1982). The results of these workers are in full agreement with the present findings of recording optimum yields at ET/PE ratio of 1.0. There was a reduction in yield when the irrigation schedule was dropped from 1.0 to 0.6 ET/PE ratio and such reduction was maximum in TMV-2 and least in Kadiri-2. Further reduction in irrigation schedules drastically reduced the yields. The reduction in yield in the present experiment is due to the less pod number per plant and their development at ET/PE ratio of 0.6 to and 0.2. Further reduction observed with T_4 (ET/PE ratio of zero) is due to the reduction in pod number, pod development and plant population. The percentage decrease in plant population at the time of harvest in T_4 was 47.48 in TMV-2, 42.56 in Kadiri-1 and 31.62 in Kadiri-2. Total quantity of irrigation water given differes with the duration of the crop and the treatments. In the present study, TMV-2 received 710 mm with T_1 whereas the other two cultivars received 810 mm and the second treatment received 430 mm in TMV-2 and 490 mm in other two cultivars. An irrigation equivalent to 710-810 mm recorded highest yields followed by the treatment which received an irrigation of 430-490 mm. The optimum water requirement was 60.6 cm (Chandra Mohan, 1970) and 40-60 cm (Stansell *et al.*, 1976). Davidson *et al.*, 1973 observed maximum moisture stress may be relatable to the short supply of photosynthates. However, Talama Reddy (1974) observed more pops with excessive soil moisture regimes.

Test weight and shelling percentage decreased with irrigation levels less than 0.6 of ET/PE ratio. The decrease in 100 kernel weight and shelling percentage might be related to the total photosynthetic area present in respective treatments, its activity and translocation. The photosynthetic rates themselves must be reduced due to increased stomatal resistance (Pallas et al., 1979).

Previous workers conducted experiments to fix up optimum irrigation levels in groundnut for realising higher yields using many techniques based on soil moisture at different depths, total quantity of water applied during the crop growth, frequency of irrigations and ET/PE ratio. In the present investigation, irrigations were scheduled using ET/PE ratio and also recorded parameters like soil moisture regimes, total quanity of water applied under different treatments and number of irrigations given. The results obtained under various treatments on the lines mentioned above were discussed here under.

Kadiri-2 recorded more yields at any level of irrigation followed by Kadiri-1 and TMV-2. All the varieties recorded highest yield at ET/PE ratio of 1.0. When this ratio was brought down to 0.6, there was a reduction of five quintals of pod yield in TMV-2, three quintals in Kadiri-1 and two quintals in Kadiri-2.

yield in peanut by applying 50.8 to 76.2 mm of water when this amount was removed from the surface 76.2 cm of soil. In the present experiment, the reduction in quantity of irrigation less than 430 to 490 mm registered nominal yields in all the cultivars.

The soil moisture percentage was worked out at three depths under various treatments (Table 18). In the upper layer (0-25 cm) the soil moisture percentage varied in tune with the time of irrigation in all the three treatments whereas the soil moisture percentage in next layer (25-50 cm) did not show marked variation between irrigation to irrigation under particular treatment. However, soil moisture regimes at any zone varied with the type of irrigationtreatment. As reported from earlier work (Keese et al., 1975) the groundnut plant has a feeding zone around 50-75 cm. The soil moisture percentage in this zone is related to the pod yields. In general, T_1 of any variety recorded a mean soil moisture percentage of 10.83, T_2 8.23%, T_3 5.57% and T_4 3.30%. As seen from the data a soil moisture regime of about 10.83 per cent recorded highest yield whereas there was drop in yield when soil moisture decreased to 8.23% under T_2 and further reduction in soil moisture under T_3 (5.57%) and T_4 (3.30%) reduced the yields drastically. Earlier workers recorded optimum yields at soil moisture tension of 1 atmosphere (Matlock, 1961) and 0.3-0.4 bars (Garbett and Rhoads, 1975), at half field capacity (Mehrotra et al., 1968), 60 per cent field capacity (Mohan, 1970) and at 60 per cent available soil moisture (Ali et al., 1974) 40 per cent soil moisture (Ome et al., 1974).

The crop was sown on 23-12-1982 and various irrigation schedules were given based on the ET/PE ratio as per the treatments and accordingly TMV-2 received a total number of 14 irrigations and other two cultivars received 16 irrigations. The interval between two irrigations was as low as 10 days during January to a part of February during which temperature was low, with high relative humidity and less radiation load. Subsequently there was raise in temperature, radiation load with decrease in relative humidity which requires frequent irrigation of about 6-8 days between two irrigations. Therefore, the frequency of irrigation depends on the environmental factors and their interplay. However, optimum yields were obtained with an irrigation interval of seven days (Rao and Srinivasulu, 1955; Goldberg et al., 1967; Radder et al., 1969) and 10 days for sandy loams (Syed Naseer Peeran et al., 1967).

There was a reduction in haulm yield with lesser quantities of water supplied in various treatments when compared to T_1. Such decrease in haulm yield with decrease in quantity of irrigation water was reported by Baumanns and Norden (1971), Khan et al. (1972) and Subash Babu (1977).

CONCLUSION

From the foregoing results and discussion, it may be concluded that the components of structural and supporting plant parts like plant height, number of primary branches, number of leaves were less with less quantity of irrigation water supplied when compared to the irrigation treatment equivalent to 1.0 of ET/PE ratio. The photosynthetic surface area was also drastically reduced with lesser irrigation schedules than 1.0 of ET/PE ratio. The reduction in photosynthetic area resulted in less dry weights in both vegetative parts like stem, petiole, leaves, root and reproductive parts like flowers, pegs, pods and other yield components. Thus in the present experiment it was evident that the adverse effects of drought were observed on all plant parts and hence there was reduction in both source size and sink size. It is also interesting to note that stem dry weights decreased with stress treatments possibly due to the remobilisation of stem sugars, during the periods of acute demand from the developing pods.

The influence of lesser irrigation schedule failed to alter the pattern of partitioning of photosynthates between vegetative and reproductive parts. Yields were drastically reduced with stress treatments beyond 0.6 of ET/PE ratio. The reduction in yields observed with treatment which was maintained without irrigation was due to the poor development of the plant stature including photosynthetic area and various yield components, and also due to the reduction in plant population owing to the death of some of the plants during the course of crop growth. Any reduction in irrigation schedule less than 1.0 of ET/PE ratio reduced both the plant growth and yield under rabi situation. The total quantity of water required for entire crop growth was 710-810 mm with irrigation equivalent to ET/PE ratio of 1.0.

The spreading and semi spreading varieties were found to be moderately tolerant to drought and suffered less comparatively with an irrigation schedule of 0.6 and 0.2 ET/PE ratio when compared to TMV-2 a bunch cultivar.

VI SUMMARY

A field trial was conducted during rabi season of 1982-83 with three varieties of groundnut (TMV-2, Kadiri-1 and Kadiri-2) on the S.V. Agricultural College Farm, Tirupati to study the effect of graded moisture stress on growth and yield. Four different soil moisture levels were imposed as treatments for the study.

It has been generally observed that the irrigation given at ET/PE ratio of 1.0 resulted in general improvement in physiological morphological parameters and yield of all the three cultivars. Irrigation with ET/PE ratio of 0.6 registered a reduced plant performance. Severe soil moisture stress treatments made the crop stunted in growth and poor plant performance.

The following are the characteristic effects of varied soil moisture levels on various plant characters.

Irrigations with a ET/PE ratio of 1.0 recorded maximum plant height, maximum number of branches (5.0 to 6.0), maximum number of leaves (46.2 to 145.6), more leaf area, more dry matter accumulation, massive vegetative growth per unit leaf area, early flowering, more number of flowers and pods produced per plant, increased pod yield and maximum test weight (25.4 to 37.27).

Irrigation with a ET/PE ratio of 0.6 registered stunted plant growth with poor yield potentiality reflected through delayed flowering, lesser production of reproductive parts and lesser shelling percentage and 100-kernel weight.

Irrigation less than 0.2 of ET/PE ratio drastically resulted in the reduction of various growth parameters. The development of reproductive parts suffered most with a treatment which received no irrigation.

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