STUDIES ON THE MIXED CROPPING COMPATABILITY OF SIX CROPS GROWN UNDER TWO SOIL MOISTURE REGIMES

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By

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This is to certify that this Thesis entitled "Studies on the mixed cropping compatability of six crops, grown under two soil moisture regimes" submitted for the degree of M.Sc.(Agriculture) in major subject AGRONOMY of the ANDHRA PRADESH AGRICULTURAL UNIVERSITY is a result of bonafied research work carried out by Sri Sudershan Sastry under my supervision and that the Thesis has not formed in whole or in part, the basis for the award of any degree, diploma or other similar degree or distinction.

The assistance and help received during the course of investigation have been fully acknowledged.

(A.VENKATA CHARI)
Major Adviser

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INTRODUCTION

C H A P T E R - 1

I N T R O D U C T I O N

Mixed cropping in India is as old as agriculture itself. Mollison (1901) has rightly pointed out that "the system of mixed crops so common in India is undoubtedly a successful and profitable method which probably has done more to uphold the fertility of Indian soil than any other practice". In over populated country like India, where food is always in short supply, manure and irrigation facilities are limited, mixed cropping practice must have an important place in sustaining agricultural production. Importance of mixed cropping was also reported by Aiyer (1949) who said that "mixed cropping marked a very material contribution towards remedying the nutritional imbalances of cultivator's diet".

For an ideal compatability of crops in mixed cropping programme a thorough knowledge of their growth pattern, canopy development, rooting habits, moisture use and nutrient uptake pattern etc., are necessary. With the advance of research, many a new varieties have been released for each crop. These varieties differ in their genetic potentials, growth habits and their reaction with environment. A detailed study of these new plant types is necessary for any useful recommendation on mixed cropping.

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In a well planned mixed cropping practice, crop-combinations are chosen in such a way that a tall and short growing, wider and narrow canopy spread, shallow and deep rooted, leguminous and non-leguminous and least competetive crops for both nutrients and moisture are combined. Incidentally such a crop-combinations also results in providing a minishelter belt effects by the tall crop to short statured crop in the field. It has been established that "well designed shelter belts often influence crop productivity and water use efficiency" (Skidmore and Hagen, 1970).

In India, with frequent droughts on one hand and erratic, inadequate, and unevenly distributed rainfall on the other, water has become a scarce and costly input of agriculture. In order to realise fuller production potential of crops, timely supply of water is essential. For this purpose, thorough studies on all aspects of moisture use like evapotranspiration requirements moisture extraction pattern from different depths and under different crop-combinations etc., are needed.

In summer, several crops are grown by irrigation with different water use efficiencies. When the crops with different growth habits are grown together under different water management practices the resulting micro-climate variations, together with the differences in soil moisture demands are likely to cause variation in total water requirements besides their effects on plant growth and yields.

Based on these ideas, an experiment was initiated at the college of agriculture, Rajendranagar to evaluate the compatability of some crops for mixed cropping grown under different soil moisture regimes and the results are presented in this Thesis.

REVIEW OF LITERATURE

C H A P T E R - 2

REVIEW OF LITERATURE

Crop production is a function of many factors like climate, physical and chemical properties of the soil, moisture supply, nutrition and management practices, besides the genetic potential of the plant itself which controls its response to environment.

A review of crop production as a function of soil moisture and interaction of crops grown by mixed-cropping is presented in the following pages:

2.1 DIFFERENT APPROACHES FOR WATER REQUIREMENT STUDIES

Krishnan (1969) while stressing the need for the study of various aspects of water management stated that generally in India deficiency of soil water during crop growth causes severe effect on production, even if facilities for irrigation are there. As water is costly and scarce input, its conservation and efficient use is essential. He further stated for knowing when, where and how much water to apply etc., the knowledge of actual evapotranspiration during various periods is essential to supplementary planning for irrigation management. He suggested number of methods to estimate actual and potential evapotranspiration:

(a) Empirical relationships between ET and climatological factors with or without soil moisture and plant factors like Lowry and Johnson (1942), Blaney-Criddle (1950), Thornth Waite (1948), Jensen and Haise (1963) Denmead and Shaw (1959) and Slatyer (1963).

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(b) Analytical methods involving aero-dynamics' approach such as those of Pasquill (1949), Thornthwaite (1960) and Swin Bank (1955) or energy balance techniques such as that of Bowen ratio and combination approaches like those of Penman (1956) Slatyer and Mcll Roy (1961) etc.

(c) Measurements by Lysimeters installed in the field such as those in Tempe, Arizona and Davis, California of U.S.A. and Melbourne, Australia (Van Bavel and Myers (1962) Pruitt and Angus (1960) Mcll Roy and Angus (1964).

(d) Water balance approach by means of soil moisture regime studies (Slatyer, 1966).

With regard to the use of Blaney-Criddle method for computing 'K' value Krishnan (1969) stated that agriculturists and irrigation engineers in the World use this method, for computing seasonal consumptive use of crops for irrigation planning.

2.2 EVAPOTRANSPIRATION OF DIFFERENT CROPS IN RELATION TO SEASON, SOIL AND YIELD.

Based on the experiments conducted at Sirugappa during Kharif and summers of 1968 and 1969 on Sorghum (CSH-1) involving three moisture regimes viz., irrigations at 25%, 50% and 75% available soil moisture depletion (A.S.M.D.) in top 30 cm. layers, Patil et al,(1969) reported that during kharif irrigation at 75% A.S.M.D. seemed to be adequate though it involved one irrigation. However, during summers of both the years irrigation at 50% A.S.M.D. gave the highest yield which was superior to

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75% A.S.M.D. and was on par with 25% A.S.M.D. Evapotranspiration for 50% A.S.M.D. treatment was 550 to 575 mm. water provided in 9 to 10 irrigations. Mohiuddin (1970) reported that during 1970 summer for sorghum (CSH-1) the total ET ranged from 28.75 cm. to 41.72 cm. when the crop was subjected to moisture stress at different stages and also no stress.

Bajra (D-174) when cultivated under three regimes viz., 25%, 50% and 75% A.S.M.D. during 1968 kharif, on heavy soil, the 25% A.S.M.D. regime gave better yields than others, though the differences were not significant (Patil et al 1969). Joshi (1969) reported that bajra (HB-1) when cultivated in summer on sandy loam soil, gave highest yield of 24.5 q/ha. at 0.2 atm.soil moisture tension, with 606 mm. of water use. At 0.4, 0.6 and 0.8 atm. soil moisture tensions, the yields obtained were 19.6, 15.4 and 11.6 q/ha. and water utilized by the crop was 547, 518 and 456 mm. respectively.

Rajgopal (1969) conducted an experiment on ragi crop in green house, on calcareous sandy loam soil and his results showed that 21.2, 19.4, 18.6 and 13.8 grams of grain per pot was attained at 20%, 40%, 60% and 75% depletion of soil moisture from field capacity. Patil et al (1969) reported that when ragi was grown in summer on heavy black soil at different soil moisture regimes in top 30 cm.layer, the 50% A.S.M.D. regime gave good yields. This involved 7 to 9 irrigations amounting to 450 mm. and during this period evaporation from open screen pan was 932 mm.

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At Sirugappa duty of water for groundnut was found to be 62 ha. on black soils (Anonymous 1943). Chandramohan (1966) at Bhavanisagar found that maximum yields of groundnut were obtained by providing irrigations at 40% A.S.M.D. in the effective root zone for which water requirements varied from 556 to 634 mm. At Yemmiganur, when groundnut crop was grown on red soils during January to April, it required 6 to 7 irrigations (Rao, 1966). Rao and Shrinivasulu (1955) reported that in summer season, groundnut (TMV-4) gave maximum yield of 1756 lb/ac. when irrigations of 50 mm. depth each were given at 10 days interval, compared to other treatments to which irrigations were given at 15, 20 and 25 days interval. Mehtrotra et al (1967) after conducting an experiment with groundnut (T-32) at Kanpur on loamy soil concluded that yield and consumptive use increased with increased depth of water applied for each irrigation (25,50,75 100 mm.). The yields and consumptive use differences were however not significant among the irrigation treatments, but these treatments were superior over rainfall 469 mm. (control) treatment.

Laxminarayana and Reddy (1969) reported that crops like local Bajra groundnut (TMV-3) and Korra had shown 3.63, 3.18 and 3.20 mm/day ET respectively during 1966 under similar soil and climatic conditions.

Irrigations at 50% A.S.M.D. were generally found to be good for economical yields.

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2.3 MOISTURE DEPLETION PATTERN FROM DIFFERENT LAYERS

Joshi (1969) reported that the moisture extraction of bajra (HB-1) on sandy loam soils in summer was 38%, 31%, 18% and 13% from successive 15 cm. soil layers respectively.

Mohiuddin (1970) reported that moisture stress during later stages of crop growth caused plants to put forth deeper roots as evidenced by higher rate of water extraction from 15-30 and 30-60 cms. soil layers (i.e. 34% and 40%) compared to 0-15 cm. layer (26%). When adequate soil moisture was there throughout the crop growth, the extraction pattern was 60% and 40% of soil moisture from 0-30 cm. and 30-60 cm. soil layers respectively. Singh and Bains (1971) exhibited the depletion percentages from various depths at different growth stages of the jowar crop (CSH-1) as shown below:

Depth	38 days	55 days	70 days	80 days age
0-20 cm.	65%	54%	45%	40%
20-40 cm.	35%	31%	33%	28%
40-60 cm.	--	15%	17%	24%
60-80 cm.	--	--	5%	8%

2.4 EVAPOTRANSPIRATION IN RELATION TO SOIL MOISTURE

Though climatic factors have influence on Et., the soil moisture status was also reported to influence Et. to a considerable extent (Laxminarayana and Reddy, (1969). Eagleman and Decker (1965) reported that as soil moisture reduced below the field capacity, the rate of Et. decreased.

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Jain (1970) reported that rate of Et. was directly related to the moisture content of the soil and stage of the castor crop growth. Baier (1964) and Jain (1967) also reported that a linear relationship existed between the rate of Et. and the moisture content of soil under the high conditions of moisture stress.

Available soil moisture present at root zone had considerable influence on the Et. of the crops.

2.5 EVAPOTRANSPIRATION IN RELATION TO CROP GROWTH PHASES

Jain (1970) reported that Et. decreased with increase in age of the castor crop except during the period of 46-75 days after planting and the rate of Et. did not vary significantly with fertilizer application levels.

Singh and Bains (1971) explained that Et. rate will increase (in sorghum) due to increased vegetative growth, more light interception and more absorption of light. They further explained that the reduced Et. rate after 85 days age of sorghum crop was due to necrotic leaves leading to lower transpiring surface.

Well developed plant canopy increased Et. through maximum light interception.

2.6 YIELD IN RELATION TO SOIL MOISTURE

Musick et al (1963) reported that the grain yields of sorghum were curvilinearly related to soil moisture availability. Significant reduction in the yield occured when

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available soil moisture was reduced to 25% in 0-30 cm.layer or 35% at 150 cm. soil layer (Musick and Grimes 1961). Patil (1967) quoted the work of Varadarajan, that for sorghum (CO-18) there was no marked difference in yields between irrigation levels scheduled at 40% and 70% of available soil moisture depletions.

Jowar (CSH-1) recorded average grain yield of 38.5 q/ha under maximisation of yield trials of high yielding variety programme at Rajendranagar (Anonymous 1972-'73). Shastry (1970) reported that under summer season the average yield recorded by sorghum (CSH-1) as 42.51 q.grain/ha.

Lower available soil moisture at root zone resulted in poor yields.

2.7 CROP BEHAVIOUR IN RELATION TO SOIL MOISTURE

Johnson (1967) concluded that grain sorghum has marked ability to remain dormant during drought and then to resume growth when moisture becomes available.

Misra et al (1966) reported that soil moisture and plant relations showed that bajra plants adjusted their leaf water potential suitably according to the continued deteriorating soil water potential, thus enabling the plants to survive under conditions of moisture stress.

Suraj Bhan and Misra (1970) observed that drought has reduced the weights of the groundnut crop roots without appreciably affecting their number and made them finer and

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more fibrous than did the favourable conditions.

Bajra and jowar crops got tendency to adjust their leaf water potential to survive in droughts. Drought resulted in more fibrous and finer root systems to crops when compared to favourable conditions.

2.8 WATER USE EFFICIENCY

Blum (1966) reported that the yield was promoted by each additional irrigation, with a decrease in water use efficiency. Viets (1964) and Olsen et al (1964) suggested that increased water use efficiency of crops due to N application was mainly through the increase in yield but with a little or without any effect on total water uptake by the plants. Skidmore and Hagen (1970b) after reviewing several works concluded that decrease in potential evaporation with shelter belts, increased yields and water use efficiency. Griffin et al (1966) reported that maximum yields and maximum Et. and minimum water use efficiency were obtained by maintaining the soil profile above 50% soil available moisture.

Suraj Bhan and Misra (1970b) reported that the water use efficiency of groundnut was 1.715 Kg.pods/mm. when Et. was 208.1 mm. and pod yields were 358.2 Kgs., but when the rise in total water use to 369.9 mm., yield increased to 1597.1 Kgs. pods and so water use efficiency increased to 4.318 Kg./mm.

Jain (1970) reported that increased water use efficiency was mainly due to increased castor yields with the N application.

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There was little effect of N on the rate of Et.

Singh and Bains (1971) reported that jowar (CSH-1) recorded higher moisture use efficiency of 15 Kgs./mm. with a lower seasonal Et. of 315 mm., with 3.0 mm/day water use. Mohiuddin (1970) reported that water use efficiency of jowar (CSH-1) varied from 0.94 q./cm. when Et. was 41.72 cm. (when no stress for moisture) to 0.75 q./cm., when Et. was 34.18 cm. (when moisture stress was imposed from 70th to 100th day).

Increased yields through increased Et. were mainly responsible for increased water use efficiency but variation in Et. had little impact on water use efficiency.

2.9 EFFECT OF MOISTURE STRESS ON CROP PHYSIOLOGY

How moisture deficiency in root zone will effect crop growth was explained by several workers.

Hadas (1969) while explaining the effect of stress on seed germination stated that, imbibition stage was little effected by the total contact area and total water stress.

Fuehring et al (1966) reported that (the effect of soil moisture depletion on crop yields and stomatal infiltration) that a partial closure of stomata was observed as early as two days after irrigation, indicating stress on plant growth even when most of the available soil moisture was still present in the soil. A linear relationship, according to them, was established between degree of stomatal opening and length of time after irrigation, under field conditions for crops like sesamum,

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castor and sorghum etc. Van Bavel and Ehrler (1968) reported that stomata regulated transpiration only during periods of darkness and low light. During the main part of the day (light period) neither increased in number of operture of stomata, nor wetting of the entire foliage, would increase the evaporative flux. The action of sorghum plant is then like that of wick. In hot and dry environment, they reported, that sorghum foliage will constantly be several degrees cooler than the ambient air, even in the middle of the day when radiant energy input is large.

Northern (1943) found that incipient drought decreased the structural viscosity of leaf cells of Bryum sp. as a consequence of protein dissociation. The shrinkage in hydrophilic groups of protein molecules leads to a mechanical tension and the exposure of bonds, which results in breaking of structure (Stocker 1961). Vasilyea (1960) determined the degree of dehydration of different cell components and found among vecuole juice, protoplasm and chloroplasts, the chloroplasts had the most stable water balance.

Jain and Misra (1970) summerized that hydrostatic pressure in roots was depressed by low soil moisture content, above the wilting percentage.

The rate of photo synthesis was more closely related to the water content of soil than diffusive capacity of stomata (Jain and Misra 1970). Pesek and Winkler (1956) concluded that modes of action due to water deficits on photosynthesis are: stomatal closure, reduced Co_2 rates of

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exchange and change in biochemical processes involved in photosynthesis. Water stress decreased the formation of new leaves (Jain and Misra 1970). Shinn and Lemon (1968) found that the limited growth, when soil moisture tension in major part of the root zone was between 0.75 and 1.5 bars and then the maximum leaf water potential was 3.5 bars. Hence they concluded that decrease in plant growth was due to increase in leaf water potentials.

Effect of water stress on respiration are apparently exerted through an influence on mobilization of enzyme substrates and also through the effects on diffusion rates of gases (Stiles 1956).

Transpiration was reduced in drying soils at relatively low moisture stress (Kramer 1949, Kozlowski 1949 and Slatyer 1956). Slatyer (1957) pointed out that, the influence of low soil moisture on transpiration varied greately among plants and was conditioned by evaporating conditions, sensitivity of stomatal closure and availability of water for absorption. He further concluded that transpiration was usually effected less, by levels of soil moisture than growth. This was attributed to passive phenomenon of transpiration. Singh (1957) concluded that more drought resistant plants had higher transpiration rate under normal water supply, however, they were more economical under restricted water supply.

Jain and Misra (1970) concluded after reviewing number of works, that increase in water deficits of the plant tissue

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brought about the hydrolysis of starch into aminoacids. RNA was also effected due to increase in water deficit. Wadleigh and Ayers (1945) stated that moisture deficit brought about an increase in NO_3 content in bean plant and had similar effect on percentage of soluble organic nitrogen. Stone and Tucker (1969) reported that a close negative relationship existed between grain nitrogen percent and amount of water applied to the soil. Possible explanation he suggested was, reduced nitrogen concentration in soil solution due to more application of water. Medriski and Wilson (1960) reported that an increase in maize plant P, K and Mg. content with an increase in the level of moisture at root zone. Jain and Misra (1970) concluded after review of many experiments that oat plants grown under dry conditions recorded a lower K/ca. ratio.

According to majority of workers, effect of moisture stress had little to do with imbibition stage but marked effect was observed on photosynthesis, transpiration and respiration. Chloroplast got more water stable capacity among cell constituents. Chemical metabolism and enzymatic relations were varied due to drought.

2.10 NUTRIENT REQUIREMENTS OF CROPS

Srivastava (1971) reported that at the time of harvest (dwarf sorghum) recorded 0.17% to 0.19% of P_2O_5 in straw and 0.52% to 0.63% in grain.

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Reddy (1971) reported that at the time of harvest bajra (HB-4) recorded 0.92% to 0.96% of nitrogen and 1.953% to 2.004% of potassium. He further reported that 19.81 to 26.40 Kg./ha. of phosphorus uptake was recorded when the yields of straw and grain recorded were 34 to 35 q./ha. and 16 to 17 q./ha. respectively.

2.11 EFFECT OF mixed CROPPING ON WATER USE ASPECTS

Stoeckeler (1962) reported that shelterbelts reduced wind velocity, wind erosion and mechanical damage to plants and also altered the factors of micro-climate, such as humidity and temperature in protected zone. This conserved the moisture by reducing evaporation and transpiration and benefited the crops. He further concluded after reviewing several experiments that (1) because of the effect of shelter belts have on the basic factors of environment they can be expected to influence yields of most crops (2) kind of crops have great deal to do with the effectiveness of protective plantings (3) relative effects tend to be greater in years of climatic stress, although yields in absolute terms may be influenced to a greater extent in good years (4) Shelter belts occupying reasonable percentages of the area can only cause an increase in total crop yield (5) The zone of influence on crop yield generally extends to leeward side.

Skidmore and Hagen (1970)[a&b] reported that shelter belts are primarily to reduce evaporation and the effect on evaporation was complicated by turbulence induced by the barrier, availability of water to evaporation sites, barrier

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porosity etc. Wind barriers change ambient air flow and thus by modifying the aerial environment, affect crop yields. The influence of shelterbelts also implied the presence of wind whose properties of speed, direction, thermal stability and turbulence level, all effect leeward airflow. In turn the leeward air flow was influenced by barrier characteristics which include permeability, hight, shape, width and resilience. Of these permeability and height were more important. High atmospheric evaporative demands caused by combination of high temperature and low relative humidity increased transpiration rate. (Gavande and Taylor, 1967).

Rosenberg (1966) cited Guyot as believing that the effect of shelter on air temperature, may be predicted on the basis of whether Et. was increased or decreased. When Et. uses more available energy less is available to heat the air. Marshall (1967) reviewed the literature on shelter in relation to micr-meteorological changes and pointed out, that wind evaporation and temperature are the most important factors which are modified due to shelter effects. He further stated that crop yields are usually higher because of shelter effects, but the increase in yield varies considerably as a result of differences in species, climate and soil.

Skidmore and Hagen (1970[b]) in their review stated that several factors like soil moisture, evaporation, transpiration, diffusion, air mixing, temperature and radiation will influence the air humidity and complicate the conditions. Many studies showed only slight variation of relative humidity

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in sheltered areas compared to unsheltered. Radiation, one of the most important factors in crop environment was slightely affected, by barrier that too only at the immediate vicinity of barrier. They further reported that reduction in CO_2 content, induced by barrier had not been reflected in yield. Eventhough barriers reduced evaporation in proportion to wind speed, the reduction in evaporation was less than the reduction in wind speed.

Brown and Rosenberg (1970) reported that the photosynthetic rate was more strongly favoured where plants grown on dry land were sheltered from wind. They further reported that due to shelter belts greater increase in yields occured in arid and semiarid areas. The beneficial effect, they explained, was due to reduced size of stomatal opertures in well watered sheltered crops as compared to well watered open area crops, which occured under extreme environmental stress. Colville (1968) reported air temperatures within the corn ecosystems were not greately modified by plant population or method of planting. However, the relative humidity increased with increasing plant population. Krishnan et al (1966) reported that humidity profile over barrier (dune) did not indicate any significant variation except in summer, when a slight increase in relative humidity was observed from the surface to 50 cm. height during early morning, noon and night times. In general there was a decrease in humidity at higher levels.

As reported by Skindmore and Hagen (1970) it is well and

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good, if proper understandings were developed from further research to comprehend well enough the relationship of shelter belts' characteristics to leeward air flow, to micro-climate and to plant response to build a workable model and use simulations to explore in more details, the consequences of various strategies of crop combinations.

2.12 EFFECT OF ADVECTIVE ENERGY ON EVAPOTRANSPIRATION

Priestley (1951) and Deacon *et al* (1958) pointed out that along with the humidity and temperature of the air advection also plays an important role in influencing natural evaporation. Philip (1959) stated that presence of advection can be recognized by the facts that the vertical mean profiles of (potential) temperature, specific humidity and wind speed are non-equilibrium in profiles, even under conditions of steady in time. He further cautioned that in fields of micrometeorology (i.e. agronomy, irrigation engineering) the neglect of the importance of advection has often resulted in wrong interpretations. de Vries (1959) observed that extra water available caused consumption of more energy in evaporation and less in heating the air and the soil. The temperature of lowest layers of air was therefore reduced by irrigation while the humidity of these layers was increased. For this it was assumed that for each height the eddy diffusivities have the same values in irrigated and unirrigated areas. Pelton *et al* (1960) reported that as a result of advection a considerable increase in Et. ratio was recorded. Hudson (1965) studied advection effects in cotton, under irrigated conditions and showed that turbulence increased markedly,

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with decreasing barrier permeability.

Saraf and Dastane (1966) reported that the frequency of irrigation for bulb onions was reduced by providing a mini shelter belt of bhendi crop around onion. The shelter belts reduced advective energy by which Et. from onion field was minimized. Rosenberg (1966) reported that, reduced vertical diffusion and mixing of air usually caused higher day time air temperatures and lower night time air temperatures. Davenport and Hudson (1967) concluded that advection was less apparent in temperate conditions than in hot arid climate (of Sudan). Skidmore and Hagen (1970[b]) concluded that under advection the turbulent transfer term may be large, hence reduction in Et. and actual Et. may be reduced less than evaporation. Saraf and Dastane (1970) reviewing several works concluded that advective energy plays an important role in water use by crops. Hanks et al (1971) reported that three types of advections were observed: 1) With in canopy advection resulted from the large amounts of exposed dry soil between rows which caused soil temperature between rows to be as much as 20°C higher than plant temperatures. About 64% energy used to heat up the soil, was used for transpiration in irrigated plot whereas only about 21% of energy was used for transpiration in the dry land plot. 2) Border advection, manifested by horizantal temperature and water vapour gradient occured over most of the plot irrigated but was most evident from 0 to 40 meters from the up wind edge. This type of advection yielded sufficient energy to account for 30% of

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energy used for Et. from the irrigated plot. 3) Large scale advection, manifested by temperature inversions was found to occur during the night and probably yielded very energy used for Et.

Shelter belts reduce advective energy and thereby Et. Advective energy plays an important role in water use and neglect of which results in wrong interpretations.

2.13 CROP PRODUCTION IN RELATION TO MIXED CROP

Several workers brought out certain advantages due to mixed-cropping. Ayyangar and Ayyar (1942) while reviewing the experiments, they concluded, that by growing together crops with differences in root habits is of great advantage because the plant food and moisture in the soil is utilized to the best advantage. As their roots feed at different depths in soil there was no competition for plant food or moisture. Bajra was usually used as a mixed crop and as mixed crop, it might be grown on the same land continusously without any apparent exhaustion of soil or diminution of outturn, if the cultivation was fairly good (Mollison 1901). Ayyangar and Ayyar (1942) reported that mixtures of groundnut with setaria were more efficient in preventing soil erosion. Sorghum and bajra when grown mixed with mung afford shade to the later. Groundnut-cotton mixture was found to be the best than pure cotton itself (Ayyangar and Ayyer 1942). Reddy et al (1965) reported that growing castor mixed with groundnut or green gram was better than raising pure castor crop in respect of yield and monetary returns. Among these two,

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castor + groundnut mixture gave significantly higher monetary returns and the percentage of increase in returns over pure castor was 61.9%. The yield of castor was more when it was grown mixed with groundnut than with korra or other crops. Lipman (1912) and Wilson (1942) have attributed better performance of groundnut-castor mixture as being due to the beneficial effect of legumes in association with non-legumes. Bodade (1964) reported that groundnut yields were depressed when sown mixed with jowar. However, jowar as an associate crop with groundnut, contributed to increase the monetary returns of the mixed cropping treatment. Jowar crop sown alone gave the lowest net return than any of the mixed cropping treatments as well as groundnut sown alone. Garg (1961) concluded that mixed cropping was the easy way for increasing agricultural production in India.

In general, mixed cropping pattern with suitable crop combination was more beneficial than these crops grown as pure crops.

2.14 MIXED CROPPING EFFECT ON YIELD CONTRIBUTING FACTORS.

Bodade (1964) reported that shelling percentage of groundnut obtained from 2 : 1 of groundnut + jowar mixture increased by 1.8%. On the other hand its natural test weight was reduced by 5%. John et al according to Bodade (1964) found that quality of groundnut such as shelling percentage and natural test weight were not effected by growing groundnut mixed with

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other crops including jowar. Bodade (1964) reported that grain weight of jowar increased due to the mixture than when sown alone.

By majority of workers, it was found that shelter belts reduce Et. and favourably affect the crop yields. However, the shelter belt effects were subjected to several modifications due to shelter belt characteristics and environmental factors.

MATERIALS AND METHODS

C H A P T E R - 3

MATERIALS AND METHODS

3.1 Site of the experiment:

The experiment was conducted on the college farm of the college of agriculture, Andhra Pradesh Agricultural University, Rajendranagar during summer, 1972. The field on which the experiment was located at an altitude of 534 meters above sea level with geographical bearing of 77° 55' east longitude and 18° 59' north latitude.

3.2 S o i l

The field was of uniform level and texture. It was well drained and consisted of reddish brown, sandy loam soil. Soil samples were drawn, from each replication and analysed for physical and chemical constituents, besides estimating the physical constants.

3.2.1 Soil chemical constituents:

Soil P_H	8.45	(Soil water ratio 1 : 2.5)
Soil E_c	0.25	mmhos/cm. (Salt Bridge)
Soil organic carbon	0.48%	(Walkey-Black method)
Available nitrogen	409.83 Kgs./ha.	(Kheldahl method)
Available phosphorus	36.30 Kgs./ha	(Olsen's method)
Available potash	315.84 Kgs./ha	(Flame Photometer)

3.2.2 Soil mechanical analysis (Hydrometer method)

Coarse sand	63.24%
Fine sand	4.00%
Silt	5.70%
Clay	27.06%

Contd...24

3.2.3 Soil physical constants

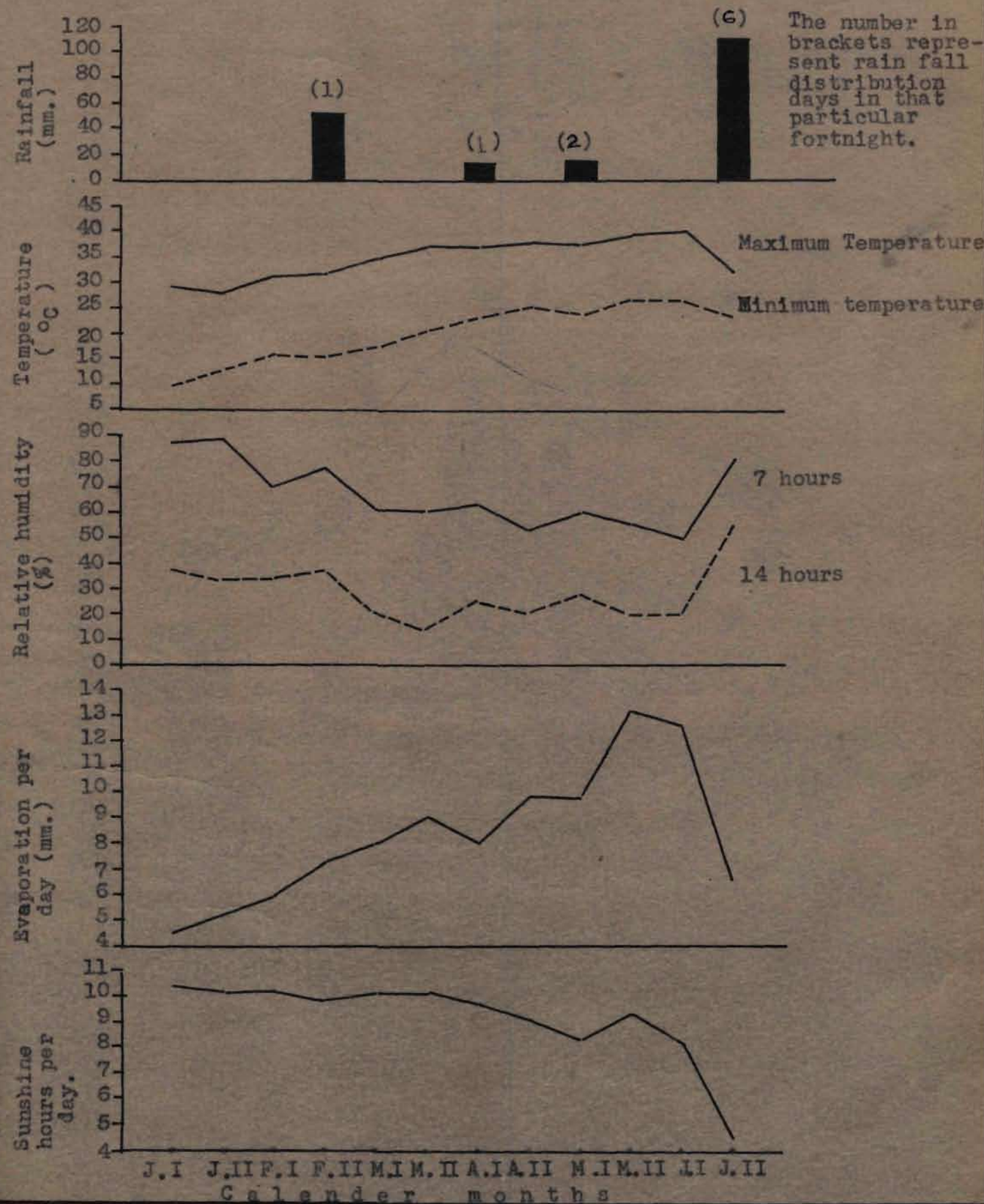
Physical constant	Depth in cms.		
	0-15	15-30	30-60
1. Field capacity (%)	15.75	15.10	15.25
2. Wilting coefficient at 15 atm (%)	5.46	5.31	5.31
3. Bulk density gms/ccs (Core method)	1.55	1.72	1.75

3.3 Season

The experiment was conducted during summer, 1972. Mateorological data recorded during the period of crop growth are given in appendix (I) and shown in Fig.(1). During the period of crop growth the total rainfall received was 82.9 mm. spread over five days. February recorded the maximum rainfall of 50 mm. on a single day. The month of March was completely dry. During the months of April and May small showers of 11.6 mm. and 17.7 mm. respectively were received. During the early stages of the crop growth (February) maximum and minimum temperatures were lower than normal. Both the mean maximum and mean minimum temperatures showed a gradual increase from February to May. Sunshine hours were maximum in the month of March. The daily evaporation from U.S. open pan evaporometer was low in February (6.62 mm/day) and increased with the advance of season till May (11.70 mm/day). These trends in climatic parameters indicated that the crop was subjected to higher temperatures at latter stages of growth.

Contd...26

Fig. 1 : METEOROLOGICAL DATA



3.4 Previous crop.

Jowar was raised during 1970 and thereafter it was fallow.

3.5 Experimental details.

The experiment included six crops, commonly cultivated in Andhra Pradesh. These included jowar (Sorghum vulgare), bajra (Pennisetum typhoides), castor (Ricinus communis), groundnut (Archis hypogea), korra (Setaria italica) and sesamum (Sesamum orientalis). These crops were grown as pure and also as intercrops, making a total of 15 treatment combinations. The 15 crop-combination treatments were subjected to two soil moisture regimes.

3.5.1 Varieties used

A brief description of the varieties used in the experiment is as follows:

3.5.1.1 Main crop varieties

3.5.1.1.1: GROUNDNUT (TMV-2): It is derived by mass selection from gudiyatam bunch in Tamil Nadu state. It was evolved at Tindivanam research station. Its average yield touches 1025 Kgs./ha. Oil content in kernels is 49.4%.

3.5.1.1.2: KORRA (T-4):

It is well suited to low rainfall regions and can withstand both hot and cold weather. It is a shallow rooted crop, well suited for mixed cropping with an average yield of 600 Kgs./ha.

Contd...27

3.5.1.1.3 SESAMUM (T-85)

The strain is a pure line selection released from Bombay. Possession of white seed coat is an important character. Seed is bold and white with an oil content of 52%. It is the most suitable sesamum variety recommended for Telangana region of Andhra Pradesh.

3.5.1.2 Inter-crop or subsidiary crop varieties

3.5.1.2.1 JOWAR (CSH-1)

It is a cross between msk 60A (female) and I.S.84 (male) It was released in 1964 as the first sorghum hybrid. It is recommended as a medium duration early irrigated summer crop for both kharif and rabi seasons. Grains are pearly cream coloured with satisfactory taste and nutritional quality. The crop is suceptable to shoot fly and stem borer and needs prompt control measures. It can yield upto 5 tons/ha. under irrigated conditions and 2 to 2.5 tons/ha. under rainfed conditions.

3.5.1.2.2 BAJRA (H.B.4)

(Parentage: Female Tift 23-A x Male local bajra). This This hybrid variety is noted for being the first to out yield its male parent which is of local origin. Grain palatability is better and the bread is sweeter in taste and has better nutritive value. It is resistant to green ear disease. Grain colour is greenish yellow.

3.5.1.2.3 CASTOR (NPH-1 - ARUNA)

This is a New Pusa Hyderabad Castor 1, a mutant of H.C.6.

Contd...29

It has been evolved by radiation treatment, 0.87 x $10^{13m}/cm^2$ of thermal neutrons. It flowers in 35 to 40 days. It tends to have many female flowers inter-spersed with male flowers, throughout the spike. It responds well to irrigation and fertilization.

3.5.2 T R E A T M E N T S

3.5.2.1 Crop combinations ... 15

1. Jowar ... (J)
2. Groundnut ... (G)
3. Bajra ... (B)
4. Korra ... (K)
5. Sesamum ... (S)
6. Castor ... (C)
7. Groundnut+Jowar (G + J)
8. Groundnut+Bajra (G + B)
9. Groundnut+Castor (G + C)
10. Korra+Jowar (K + J)
11. Korra+Bajra (K + B)
12. Korra+Castor (K + C)
13. Sesamum+Jowar (S + J)
14. Sesamum+Bajra (S + B)
15. Sesamum+Castor (S + C)

3.5.2.2 Soil moisture regimes ... 2

1. Irrigation at 40% available soil moisture depletion (A.S.M.D.)
2. Irrigation at 60% available soil moisture depletion (A.S.M.D.)

Contd...29

3.5.3 Experimental design: Experiment was laid out in a split plot design (fig.2) with 15 cropping patterns as main plot treatments and the two soil moisture regimes as subplot treatments.

The treatments were replicated three times.

Gross plot size (6.75 x 4.5) m^2

Though the net plot area remained constant, the length and width of the plot varied as shown below:

Net subplot area of sesamum sown plots (4.05 x 3.89) m^2

Net subplot area of other than sesamum sown plots (4.5 x 3.5) m^2

3.5.4 Crop spacings.

3.5.4.1 Spacing for pure crops.

Groundnut	: 22.5 cms. x 10.16 cms.
Korra	: 22.5 cms. row to row and continuous sowing within the row
Sesamum	: 30 cms. row to row and continuous sowing within the row
Jowar and Bajra	: 45 cms. x 15 cms.
Castor	: 45 cms. x 22.5 cms.

3.5.4.2 Spacing for mixed crop treatments

Spacing arrangement in mixed crop treatments are presented in table-1.

(table-1 on page no.29)

Contd..30

Fig. 2: LAYOUT PLAN

→ N

sub-plot Main plot(6.75 m.)

-4.5 m.

Replication I

Sesamum B	+Castor A	Jowar B	A	Sesamum B	+Jowar A	Castor A	B	Korra A	+ Bajra B
Korra B	+ Jowar A	Bajra A	B	Groundnut A	B	Groundnut+Jowar A	B	Sesamum A	(Til) B
Groundnut+Bajra B	A	Korra+Castor A	B	Korra A	B	Groundnut+Castor B	A	Sesamum+Bajra B	A

Replication II

Castor A	B	Groundnut+Bajra A	B	Sesamum A	B	Korra+ A	Jowar B	Sesamum+Bajra B	A
Korra B	A	Sesamum+Jowar B	A	Groundnut+Jowar B	A	Groundnut+Castor A	B	Groundnut A	B
Korra+ B	Castor A	Bajra A	B	Sesamum+Castor A	B	Jowar (Sorghum) B	A	Korra A	+ Bajra B

Replication III

Groundnut+Bajra B	A	Korra+Jowar A	B	Sesamum+Castor A	B	Groundnut+Jowar B	A	Sesamum+Jowar B	A
Bajra B	A	Groundnut A	B	Korra+Bajra B	A	Castor B	A	Groundnut+Castor A	B
Jowar A	B	Sesamum+Bajra A	B	Korra + B	Castor A	Korra A	B	Sesamum A	B

A - 40% available soil moisture depletion regime
B - 60% available soil moisture depletion regime

Table (1)

Spacing arrangement in crop combinations

Name of the main crop	Row to row spacing of main crops (in cms.)	Space between main crop row to inter-crop row. (in cms.)	No.of main crop rows	No.of inter-crop rows	Ratio of main crop rows to inter-crop rows.
Groundnut	22.5	22.5	16	4	4 : 1
K o r r a	22.5	22.5	16	4	4 : 1
Sesamum	30.0	22.5	12	3	4 : 1

3.6 Field operations: The dates of operations starting from preparatory cultivation till the time of harvest are given in table (3) (table 3 on page 34).

3.6.1 Preparatory cultivation: The field was ploughed with tractor drawn disc plough and then tiller was run twice. After harrowing, the field was given a final levelling and layout was taken up.

3.6.2 Application of fertilizers: Each crop was given the required doses of fertilizers as shown in table (2) which were applied through band placement. In intercrop fertilizer requirements were calculated for each crop row and were applied through band placement.

(Table 2 on Page no.30)

Initial dose of N, P_2O_5 and K_2O were applied as basal dose. The remaining dose of N for jowar was given in two equal splits at 25th and 40th day after sowing. For other

Contd...32

Table (2)

Fertilizer schedule

Crop	Fertilizers applied in Kgs./ha.		
	N	P_2O_5	K_2O
Jowar	120 (3)	60	30
Bajra	120 (2)	60	30
Castor	80 (2)	40	40
Groundnut	20 (2)	45	30
Korra	120 (2)	60	30
Sesamum	40 (2)	40	40

(The figures in parentheses indicate number of split doses.)

crops the remaining second dose of N was top dressed on the 25th day after sowing.

3.6.3 Seeds and sowing: Sowing was done by dibbling seeds at the bottom of the furrow on 9th February, 1972. Germination in all the crops was about 90%. Thinning was carried out to have one plant of jowar and castor per hill. A continuous sown line was maintained in case of korra and sesamum. Two plants per hill were ensured in case of bajra and groundnut crops. Gap filling was attended to on the 8th day after sowing wherever necessary.

3.6.4 Irrigation: Soon after sowing the field was irrigated and a second life irrigation was provided on sixth day to ensure good germination. The crop received 50 mm. rainfall on 11th day after sowing. From this period onwards 40%

Contd...33

and 60% A.S.M.D. regimes were maintained by providing irrigations, after sampling on different dates. By this way 40% A.S.M.D. treatment required seven irrigations and 60% A.S.M.D. regime treatment required five irrigations.

3.6.5 Interculture: Three weedings on 15th, 25th and 40th days were given to keep the crop weed free. Earthing up was attended to for bajra and groundnut and nipping of side shoots was done in castor.

3.6.6. Plant protection: As a prophylactic measure, sprayings with Endrin 0.03% and Parathion 4 ozs/1 gallon of water alternately were carried out every fortnight for all the crops, starting from 15th day after sowing upto the grain filling stage. In addition to this, some special measures were taken for certain crops such as:

3.6.6.1 Groundnut In order to prevent root grub, Thimmet was applied to soil before sowing. Against Tikka leaf disease 0.02% Thiovit spray was given. To have a proper control over leaf minor, Parathion at the rate of 4 oz/1 gallon of water was sprayed.

3.6.6.2 Jowar: For sorghum a basal application of Thimmet at the time of sowing was done, at the rate of 10 Kg./ha. A fortnight after sowing, 10% Endrin granules were applied to the whorls, followed by 0.03% Endrin spray.

3.6.6.3 Sesamum: Sesamum slightly suffered from little leaf (virus) disease. The affected plants were pulled out, whenever they appeared.

Contd...34

3.6.7 Harvesting: After leaving aside the border plants and observation plants the entire crop in the net area of experimental plots was harvested. Observation plants and border plants, were harvested separately.

3.6.8 Threshing: After sun-drying the produce from the net plot hand threshing and cleaning, were carried out. To this, the produce from observation plants was subsequently added, to make up the product for entire net plot area.

Table (3)

Field operation-wise dates

Sl.No.	Name of the operation	Date of operation
	I. Preparatory cultivation:	
1.	Ploughing	29-1-1972
2.	Tiller working	3-2-1972
3.	Harrowing	5-2-1972
4.	Layout	7th and 8th February, '72
	II. Fertilizer application:	
1.	Basal application	8-2-1972
2.	Top dressing for jowar	5th and 20th March, 1972
3.	Top dressing for other than jowar crops	5-3-1972
	III. (a) Sowing	9-2-1972
	(b) Thinning and gap filling ..	17-2-1972
	IV. Irrigation:	
1.	Life irrigation	9-2-1972
2.	First irrigation	15-2-1972

Contd..35

Table (3) contd...

Sl.No.	Name of the operation	Date of operation
3.	Irrigations for 40% A.S.M.D. regime treatment	
a.	I Irrigation	3-3-1972
b.	II Irrigation	15-3-1972
c.	III Irrigation	25-3-1972
d.	IV Irrigation	5-4-1972
e.	V Irrigation	15-4-1972
f.	VI Irrigation	25-4-1972
g.	VII Irrigation	7-5-1972
4.	Irrigations for 60% A.S.M.D. regime treatment	
a.	I Irrigation	7-3-1972
b.	II Irrigation	23-3-1972
c.	III Irrigation	8-4-1972
d.	IV Irrigation	24-4-1972
e.	V Irrigation	8-5-1972
	V. Interculture	
	I Weeding	25-2-1972
	II Weeding	5-3-1972
	III Weeding	20-3-1972
	V.(2) Earthing up	5th and 20th March, 1972
	V.(3) Nipping the side shoots of castor	25-3-1972 5-4-1972 and 10-4-1972
	VI. Plant protection:	
	1. Basal application of Thimmet (for jowar and groundnut) ..	9-2-1972
	2. Thiovit spraying (for groundnut)..	19-3-1972

Contd...36

Table (3) contd...

Sl.No.	Name of the operation	Date of operation
3.	Parathion spray (for groundnut)	5-5-1972
4.	Endrin granule's application in whorls (for jowar)	24-2-1972
5.	For all crops: Endrin spray ..	25-2-1972
6.	Parathion spray	10-3-1972
7.	Endrin spray	25-3-1972
8.	Parathion spray (not for korra) ..	9-4-1972
9.	Endrin + Parathion spray (not for korra)	25-4-1972
VII	HARVESTING:	
	Harvesting of:	
1.	K o r r a	26-4-1972
2.	S e s a m u m	21-5-1972
3.	B a j r a	26-5-1972
4.	J o w a r	1-6-1972
5.	G r o u n d n u t	3-6-1972
6.	C a s t o r	14-6-1972

3.6.9 : CROP DURATION:

Table (4)

CROP DURATION

Sl.No.	Name of the crop	Duration in days
1.	Korra	77
2.	Sesamum	102
3.	Bajra	107
4.	Jowar	113
5.	Groundnut	115
6.	Castor	126

Contd...37

3.7 OBSERVATIONS

Observations were recorded on the main and intercrop, in intercropped treatment. To study the effect of intercrop on the main crop, two plants each in the main crop row, adjacent to intercrop and also away from the intercrop, were chosen at random. Two plants from intercrop were also chosen for periodical observations. In pure crop treatments two plants at random were chosen for all observational purposes. Selection of observation plants is clearly illustrated in figure(3).

3.7.1 PLANT OBSERVATIONS:

3.7.1.1: Pre-harvest observations:

3.7.1.1.1 Plant height: Periodical plant heights was recorded, starting from 30th day after sowing. The measurement was taken from the base of the plant to the top of fully opened leaf (upto flowering time) and subsequently upto the tip of earhead (after flowering).

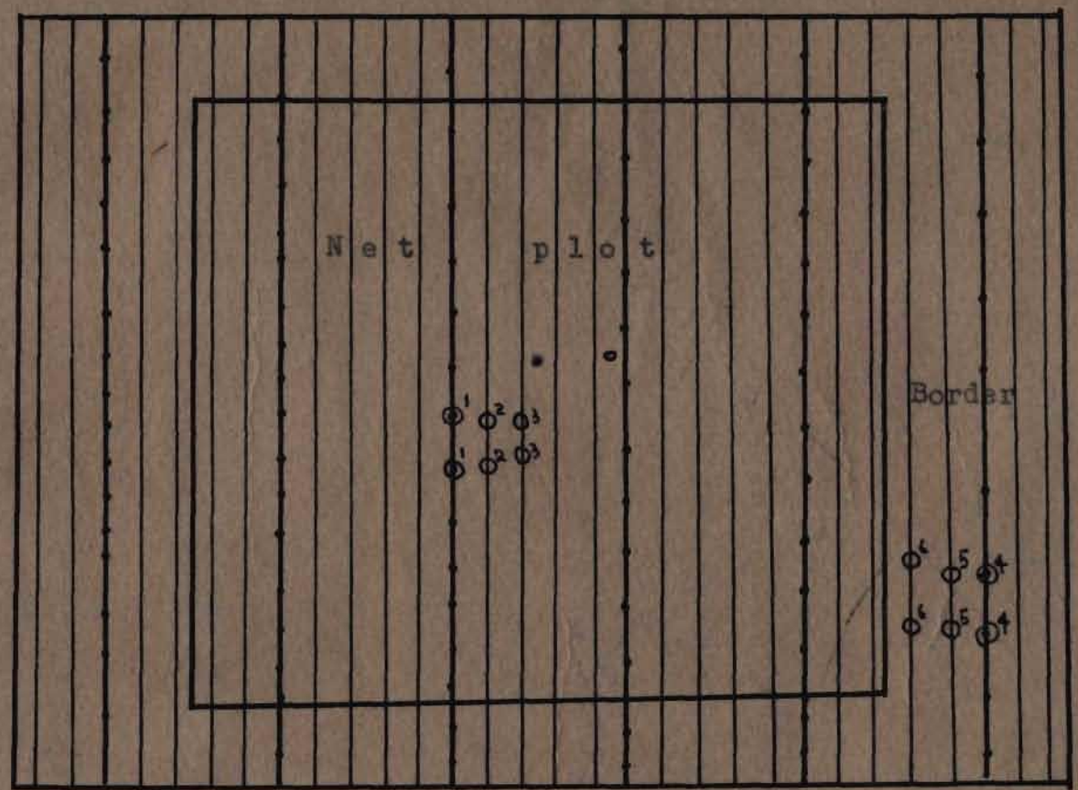
3.7.1.1.2 Number of green leaves per tiller or branch: Number of green leaves per tiller or branch, was recorded at the final stage of crop growth. Leaves were counted from the base of the stem upto the top of fully opened leaf.

3.7.1.1.3 Number of days for 50% bloom: The date on which 50% of the plants flowered was recorded in each treatment and duration in days from sowing had been worked out.

3.7.1.1.4 Dry matter production: From border areas as shown in figure (3) two plants each were taken at one month,

Contd...38'

Fig.3 : DIAGRAM SHOWING LOCATIONS OF SOIL MOISTURE SAMPLING AND OBSERVATION PLANTS IN A SUB-PLOT.



—— Main Crop

- - - Inter-crop

● Soil samples drawn in between two main crop rows
○ Soil samples drawn in between main crop row and intercrop row

both from net plot area.

⊙' Observation plants from intercrop rows
⊙' Observation plants from main crop row adjacent to inter crop row
⊙' Observation plants from main crop row away from intercrop row

for plant characters.

○' Plant samples of main crop adjacent to intercrop row
○' Plant samples of main crop away from intercrop row
⊙' Plant samples of intercrop from intercrop row

from the border plot area for the purpose of dry matter content.

two month and final stage of the crop. These samples were dried in air draft oven for 12 hours at 70°C and then weighed.

3.7.1.1.5 Number of days for maturity: The dates on which crops in each plot reached maturity were noted and the number of days from sowing to maturity calculated.

3.7.1.1.6 Plant spread: Plant spread between rows was recorded, at 30th day of crop, to estimate the extent of shading of intercrop, over the main crop.

3.7.1.1.7 Tillers or branches: Number of tillers/hill, effective tillers per hill or number of branches per plant as may be applicable were recorded.

3.7.1.1.8 Plants per unit area: In crops like korra and sesamum number of plants per unit area and number of panicles per unit area in korra and number of pods per plant in sesamum were recorded.

3.7.1.2 : Post-harvesting observations:

These observations are listed in crop wise.

3.7.1.2.1 Groundnut:

1. 100 kernel weight
2. Weight of the pods/plant
3. Shelling percentage
4. Number of mature pods/plant
5. Number of unsuccessful gynopores/plant
6. Yield of pods/ha.
7. Yield of haulms/ha.

Contd...40

3.7.1.2.2: Korra:

1. 1000 seed weight
2. Yield per ½ mt. row length
3. Yield of grain/ha.
4. Yield of straw/ha.

3.7.1.2.3: Sesamum:

1. 1000 seed weight
2. Weight of seed/plant
3. Yield of pods/plant
4. Number of pods per plant
5. Percent of seed to pods by weight
6. Yield of seed/ha.
7. Yield of stalks/ha.

3.7.1.2.4: Jowar:

1. 1000 seed weight
2. Weight of the grains/plant
3. Yield of grain/ha.
4. Yield of straw/ha.

3.7.1.2.5: Bajra:

1. 1000 seed weight
2. Weight of the grains/hill
3. Yield of grain/ha.
4. Yield of straw/ha.

3.7.1.2.6: Castor:

1. 100 seed weight
2. Weight of the pods/plant
3. Percent of seed to pods by weight

Contd...41

Castor contd...

4. Number of pods per plant

5. Yield of seed/ha.

6. Yield of stalk/ha.

3.7.1.3: Monetary returns/ha.

Yields of the plot were converted into monetary returns, because of different crops involved in the experiment. The market values at the time of harvest (average of 15 days prices from the price list at the Office of Secretary Marketing committee, Osmangunj, Hyderabad) was taken as the basis for calculating monetary returns. The sale values taken were as shown below:

Crop	Rs./q.
Jowar ..	78-20
Bajra ..	75-25
Castor seed ..	135-33
Groundnut pods.	113-20
Korra ..	68-43
Sesamum ..	240-50

3.7.2 SOIL MOISTURE OBSERVATIONS

3.7.2.1 Sampling for moisture studies: Before each irrigation soil samples were drawn from three depths 0-15, 15-30 and 30-60 cms. in all the treatments of two replications. Soil samples in ~~mixed~~ cropped treatments were taken between the main crop and inter crop and also between the two main crop rows as shown in figure (3). Sampling was also done 24 hours after irrigation, in the same way as before irrigation, to make sure if the entire plot area was wetted to field capacity. One or two samples were taken frequently to know the time of irrigation for irrigation schedules.

Contd...42

3.7.2.2 : Moisture was estimated gravimetrically and from this, soil moisture depletion at root zone, consumptive use, moisture extraction pattern, from different layers and water use efficiency were calculated.

3.7.2.3 : Water use efficiency and Et. ratio: As different cropswwere involved in the experiment, the monetary returns from each crop combination were taken as a basis for purpose of comparison. With this water use efficiency was calculated as:

$$\text{Water use efficiency} = \frac{\text{Value of economic produce in Rs.}}{\text{Cm. of water used.}}$$

Evapotranspiration ratio was calculated as:

$$\text{Et. ratio} = \frac{\text{Lit. of water required}}{\text{Value of economic produce in Rupees.}} = \text{Lit. of water required to produce one rupee worth of economic produce.}$$

3.7.2.4 Crop coefficient: The Blaney-Criddle (1950) formula U = KF was used to determine the seasonal coefficient 'K'. Where

U = consumptive use in inches
F = $\leq f$
f = $\frac{P \times t}{100}$

(P = monthly percentage of day time hours of the year and
t = mean monthly temperature in degrees Fahrenheit
U = $\leq u$ (where small u monthly consumptive use in inches)

Fortnightly and seasonal consumptive use crop coefficients were computed based on estimated fortnightly consumptive use.

3.7.3 Micro-climatic observations: The temperature and humidity variations in the crop were recorded by Psychrometer

Contd...43

in one replication, in all the treatments. First reading was taken at the said surface and subsequent readings were taken at every 15 cm. height, upto 30 cm. above the tallest crop height. In all three observations were taken after the crops reached 60 days of age

3.8 CHEMICAL ANALYSIS

Plant samples drawn at harvest were analysed for nitrogen (Micro Kjeldhal method) phosphorus (Vando-molybdenum method) and potassium (Flame Photometer). Based on the percentages of N, P and K, uptake of N, P and K per ha. was estimated. (Jackson, 1967 Rajendra prasad 1970)

3.9 STATISTICAL ANALYSIS

Fisher's analysis of variance method was used for all statistical analysis. The significance level of 5% was taken as criteria. Standard error and critical difference at 5% were presented wherever necessary.

Monetary returns/ha. and water use aspects were analysed statistically in split plot design. All plant characters were analysed in randomized block design for each crop. Sample 'Analysis of Variance' tables were given in appendix (III), (IV) and (V).

RESULTS

C H A P T E R - 4

R E S U L T S

The experimental findings in respect of crop performance, have been discussed crop-wise, while the findings on soil moisture utilization aspects have been presented separately.

4.1 CROP CHARACTERS

4.1.1 Main crops:

4.1.1.1 GROUNDNUT: The data pertaining to the trends in various crop characters are presented in table (5).

(Table 5 is given on page 45)

Inter crops, jowar, bajra and castor had differential effect, on various characters of groundnut crop. The inter crop effect on adjacent rows of groundnut was different compared to the rows away from it. Number of mature pods/plant, got reduced significantly with jowar crop association (5.2 pods per plant* and 6.2 pods per plant**) and with bajra crop association (5.7 pods per plant* and 5.8 pods per plant**) compared to pure groundnut crop treatment (9.3 pods per plant). Groundnut crop in association with castor crop produced 8.3* and 8.6** mature pods/plant which were on par with the number on groundnut crop treatment. Weight of pods/plant reduced significantly with jowar crop association (9.2 gm.* and 9.7*gm.**) compared to that in pure crop (17.7 gms.). In respect of other characters, which were not significant, the main trends

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* corresponds to main crop rows adjacent to inter crop row.
** corresponds to main crop rows away from inter crop row.

Contd...47

Table (5)

GROUNDNUT CROP CHARACTERS

Sl No	Characters	Soil moisture regime (% ASM depleted)	Pure groundnut crop	Groundnut grown along with jowar A	jowar B	bajra A	bajra B	castor A	castor B	Mean	Variants	F-Test	S.E.	C.D. at 5%
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.
1.	Plant height (in cms.)	40	25.6	30.1	25.6	26.5	25.5	27.3	25.6	26.4	*	N.S.	1.98	--
		60	24.6	26.2	24.9	25.4	25.3	28.3	29.4	26.3	**	N.S.	1.05	--
		Mean	25.2	28.2	25.3	25.9	25.4	27.8	27.2	26.4	***	N.S.	2.79	--
2.	No.of leaves/ branch	40	4.0	4.0	3.5	4.0	4.5	4.0	4.0	4.0	--	--	--	--
		60	3.3	4.0	4.0	4.0	4.0	4.0	4.0	3.9	--	--	--	--
		Mean	3.7	4.0	3.8	4.0	4.3	4.0	4.0	4.0	--	--	--	--
3.	No.of branches/ plant	40	3.3	3.5	4.5	4.0	4.5	5.0	3.8	4.1	--	--	--	--
		60	3.0	2.5	3.5	3.5	4.5	3.5	3.5	2.9	--	--	--	--
		Mean	3.2	3.0	4.0	3.8	4.5	4.3	3.3	3.5	--	--	--	--
4.	Days to 50% flower	40	40	39	39	40	40	39	39	39	--	--	--	--
		60	40	40	40	40	39	39	40	40	--	--	--	--
		Mean	40	40	40	40	40	39	39	40	--	--	--	--
5.	Days to maturity	40	112	112	112	110	110	111	111	111	--	--	--	--
		60	111	112	112	111	111	111	111	111	--	--	--	--
		Mean	112	112	112	111	111	111	111	111	--	--	--	--
6.	Drymatter production in gms/ plant	40	16.0	11.3	15.0	12.5	13.7	13.3	18.1	14.3	*	N.S.	2.40	--
		60	13.0	9.3	11.3	13.5	12.7	12.0	15.7	12.5	**	N.S.	1.30	--
		Mean	14.5	10.3	13.2	13.0	13.2	12.7	16.9	13.4	***	N.S.	3.40	--

Table contd...46

Interactions

Table (5) contd...

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
7.	Test weight gms/100 kernels	40	30.61	26.14	24.02	22.49	26.81	27.76	27.29	26.45	*	N.S.	3.66	--
		60	24.02	24.85	24.64	20.76	23.30	20.38	28.63	24.37	**	N.S.	1.95	--
		Mean	27.32	26.49	24.34	22.63	25.06	24.07	27.96	25.41	***	N.S.	5.18	--
8.	Pod weight in gms./plant.	40	18.3	9.3	11.3	9.3	11.3	14.3	16.0	13.0	*	S	2.92	6.00
		60	17.0	9.0	8.0	9.6	13.6	12.0	15.6	12.0	**	N.S.	1.56	--
		Mean	17.7	9.2	9.7	9.5	12.5	13.2	15.8	12.5	***	N.S.	4.12	--
9.	Shelling percentage	40	64	71	72	66	69	72	72	69	*	N.S.	3.55	--
		60	63	66	65	65	65	66	60	64	**	S.	1.90	3.90
		Mean	63	68	68	65	67	69	66	67	***	N.S.	5.00	--
10.	No.of mature pods/plant	40	8.5	4.9	5.7	5.5	6.5	8.1	8.3	6.8	*	S	1.46	3.02
		60	10.1	5.5	6.6	5.9	5.2	8.6	9.0	7.2	**	N.S.	0.78	--
		Mean	9.3	5.2	6.2	5.7	5.8	8.3	8.6	7.0	***	N.S.	2.06	--
11.	Unsuccessful gynopores/ plant.	40	1.30	1.06	1.06	1.06	1.20	1.60	1.06	1.20	*	N.S.	0.32	--
		60	1.40	0.80	1.06	1.13	1.00	0.93	1.40	1.10	**	N.S.	0.17	--
		Mean	1.35	0.93	1.06	1.09	1.10	1.27	1.23	1.15	***	N.S.	0.45	--

A = Adjacent to intercrop row
B = Away from intercrop row

* = Crop treatments
** = Soil moisture regimes
*** = Crop treatments x soil moisture regimes.

S = Significant
N.S = Not significant.

were as follows: Castor crop, grown as an intercrop in groundnut, did not affect dry matter production/plant and test weight, whereas it resulted in reduction in pod yield/plant and increase in shelling percentage, as compared to pure crop treatment of groundnut. In general groundnut crop rows away from castor recommended higher values of yield contributing characters as compared to rows adjacent to castor crop. This trend was also observed with other two inter crops as well. Except shelling percentage all other yield components of groundnut were decreased when grown with bajra crop which were further reduced with jowar crop association. However, jowar crop association increased shelling percentage of groundnut crop, than any other treatment. Increased shelling percentage of groundnut with jowar crop association, was also reported by Bodade (1964).

Significant increase in shelling percentage was recorded in 40% A.S.M.D. regime (69%) as compared to that in 60% A.S.M.D. regime (64%).

4.1.1.2 KORRA: The data pertaining to korra crop characters are presented in table (6).

(Table 6 is given on page 48)

Height of korra crop decreased significantly in rows away from jowar intercrop (58.5 cm. ht.)compared to pure crop (74.8 cm. ht.). With jowar as intercrop, number of plants/ unit row length, number of panicles/unit row length and grain yield/unit row length, were significantly lower in korra crop

Contd...50

Table (6)

KORRA CROP CHARACTERS

Sl No	Character	Soil moisture regime (% ASM depleted)	Pure korra crop	Korra grown along with jowar A	Korra grown along with jowar B	Korra grown along with bajra A	Korra grown along with bajra B	Korra grown along with castor A	Korra grown along with castor B	Mean	Vari-ants	F-Test	S.E.	C.D. at 5%
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.
1. Plant height (cms.)		40	80.6	70.6	64.6	78.0	77.6	86.0	77.6	76.4	*	S	7.15	14.70
		60	69.0	55.6	52.3	67.3	70.6	78.3	82.0	67.9	**	S	3.90	8.02
		Mean	74.8	63.2	58.5	72.6	74.1	82.1	79.8	72.2	***	N.S.	10.14	--
2. No. of leaves/ tiller		40	4.3	5.5	5.0	4.5	4.0	6.0	6.5	5.1	--	--	--	--
		60	4.0	4.5	5.0	4.5	3.5	3.5	4.5	4.2	--	--	--	--
		Mean	4.2	5.0	5.0	4.5	3.8	4.8	5.5	4.7	--	--	--	--
3. No. of plants/ ½ mt. row length		40	29.7	19.0	16.3	27.0	23.6	21.3	27.0	23.4	*	S	2.92	6.00
		60	33.3	20.0	18.0	37.7	33.3	24.0	29.7	28.0	**	S	1.55	3.19
		Mean	31.5	19.5	17.2	32.3	28.5	22.7	28.3	25.7	***	N.S.	4.12	--
4. No. of panicles per ½ mt. row		40	24.6	17.4	14.6	24.6	22.0	21.6	23.6	21.2	*	S	2.45	5.04
		60	23.0	17.0	14.4	29.4	23.0	21.6	25.6	22.0	**	N.S.	1.30	--
		Mean	23.8	17.2	14.5	27.0	22.5	21.6	24.8	21.6	***	N.S.	3.46	--
5. Days to 50% flower		40	29	30	30	29	29	29	29	29	--	--	--	--
		60	28	30	30	29	29	29	29	29	--	--	--	--
		Mean	29	30	30	29	29	29	29	29	--	--	--	--
6. Days to maturity		40	75	75	75	75	74	74	75	75	--	--	--	--
		60	75	75	75	75	75	74	74	75	--	--	--	--
		Mean	75	75	75	75	75	74	75	75	--	--	--	--

Table contd.on P.49

Table (6) contd...

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.
7.	Dry matter production gms./plants of ½ mt. row	40	56	36	28	50	49	51	42	45	*	N.S.	9.64	--
		60	41	26	29	50	34	47	38	38	**	N.S.	5.15	--
		Mean	48	31	28	50	41	49	40	42	***	N.S.	13.60	--
8.	Test weight gms./1000 seed	40	2.17	1.84	1.96	1.92	1.97	2.22	1.94	2.00	*	N.S.	0.10	--
		60	1.87	1.81	1.81	1.87	1.87	2.02	1.88	1.88	**	S	0.05	0.11
		Mean	2.02	1.83	1.89	1.90	1.92	2.12	1.91	1.94	***	N.S.	0.15	--
9.	Grain wt. gms./ ½ mt. row length	40	21.5	14.2	10.6	20.8	14.6	19.3	12.6	16.2	*	S	3.26	6.70
		60	14.0	10.2	10.0	20.6	12.6	17.6	13.6	14.1	**	N.S.	1.73	--
		Mean	17.9	12.2	10.3	20.7	13.7	18.5	13.2	15.2	***	N.S.	4.62	

A = Adjacent to intercrop row
B = Away from intercrop row

* = Crop treatments
** = Soil moisture regimes
*** = Crop treatments x soil moisture regimes

S = Significant
N.S = Not significant.

Setaria and other crops in the experiment

Setaria in mixed cropping

as compared to those in pure korra crop. With bajra grown as an intercrop, grain yield/unit length of korra of the adjacent row was significantly superior to that of the row away from it. For other characters, the differences were not significant. Dry matter production/unit row length and test weight were not affected by the association of castor and bajra intercrops. In general, korra crop rows adjacent to inter crop row recorded superior yield contributory characters as compared to those away from the inter crop rows. This trend is different from what has been observed in other two main crops viz., groundnut and sesamum.

Plant height and test weight increased significantly in 40% A.S.M.D. regime compared to 60% A.S.M.D. regime.

4.1.1.3 SESAMUM: The data related to sesamum crop characters are presented in table (7).

(Table 7 is given on page 52)

Sesamum crop recorded poor height upto an age of 43rd day and thereafter the height increased rapidly to 72 cms. by the age of 72 days (Fig.4 and Appendix VI). Sesamum seed yield/plant decreased significantly when associated with the inter crops as compared to a pure crop. In association with bajra crop, test weight and pod weight/plant of sesamum decreased significantly. Dry matter/plant, number of pods/plant and percent of seed to pods, were not affected significantly by inter cropping in sesamum crop.

Except pod number/plant, all other yield characters recorded higher contribution under 40% A.S.M.D. compared to 60% A.S.M.D. regime.

Contd...55

Table (7)

SESAMUM CROP CHARACTERS

Sl No	Character	Soil moisture regime (% ASM depleted)	Pure sesamum crop	Sesamum grown along with jowar A	jowar B	bajra A	bajra B	castor A	castor B	Mean	Variants	F-Test	S.E.	C.D at 5%
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1.	Plant height (in cms.)	40	78.3	74.3	93.3	82.7	73.6	74.7	83.3	80.8	*	N.S.	8.14	--
		60	77.7	72.3	88.0	67.3	59.7	74.0	76.3	73.6	**	N.S.	4.35	--
		Mean	78.0	73.3	93.1	75.0	66.2	74.3	79.8	77.2	***	N.S.	11.50	--
2.	No.of leaves/ branches.	40	7.6	12.0	11.5	5.0	5.5	8.5	7.5	8.0	--	--	--	--
		60	7.0	6.0	8.5	5.0	5.0	8.5	6.0	6.6	--	--	--	--
		Mean	7.3	9.0	10.0	5.0	5.2	8.5	6.7	7.4	--	--	--	--
3.	Branches/plant	40	3.0	2.6	2.0	2.6	3.3	0.6	1.6	2.3	*	N.S.	0.87	--
		60	2.3	1.0	1.0	0.3	1.6	3.0	4.0	1.9	**	N.S.	0.46	--
		Mean	2.6	1.8	1.5	1.5	2.5	1.8	2.8	2.1	***	N.S.	1.23	--
4.	Days to 50% flowering.	40	36	38	38	38	38	37	37	38	--	--	--	--
		60	36	37	37	38	38	37	37	37	--	--	--	--
		Mean	36	38	38	38	38	37	37	38	--	--	--	--
5.	days to maturity	40	98	98	98	99	99	99	99	99	--	--	--	--
		60	98	99	99	99	99	98	98	99	--	--	--	--
		Mean	98	99	99	99	99	99	99	99	--	--	--	--
6.	No.of plants/ ½ mt. row length.	40	8	9	10	10	10	10	10	10	--	--	--	--
		60	9	11	11	10	10	10	10	10	--	--	--	--
		Mean	9	10	10	10	10	10	10	10	--	--	--	--

Table contd... 53

Table (7) contd...

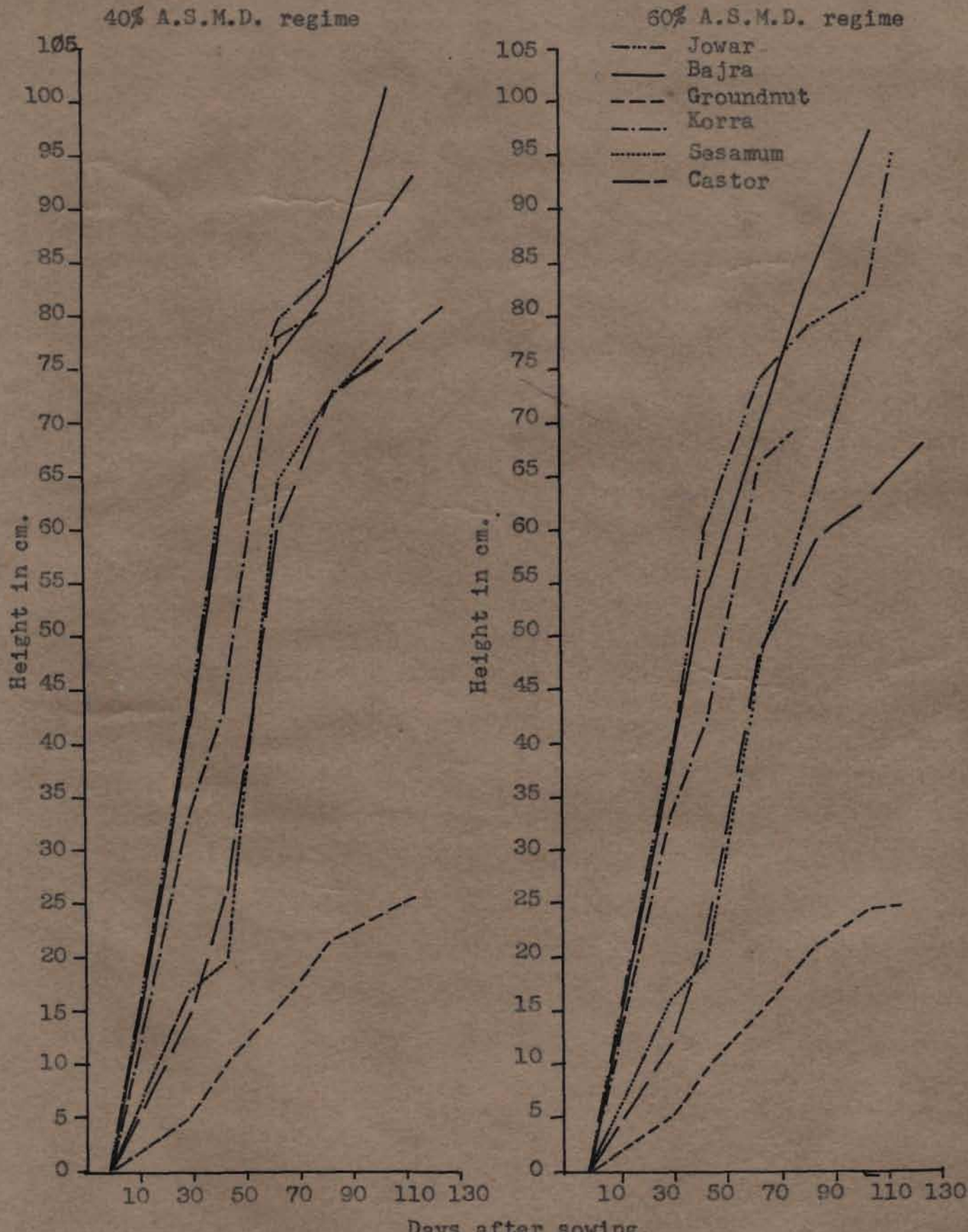
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.
7.	Dry matter production gms./plant	40	26.3	28.3	26.9	21.6	23.3	21.1	21.4	24.0	*	N.S.	1.83	--
		60	24.7	18.5	19.1	20.2	21.1	20.1	22.3	20.9	**	S.	0.98	2.01
		Mean	25.5	23.4	22.5	20.9	22.2	20.6	21.9	21.0	***	N.S.	2.59	--
8.	Test weight gms./1000 seed	40	3.05	2.83	2.88	2.36	2.41	2.78	2.77	2.73	*	S	0.15	0.30
		60	2.85	2.55	2.54	2.25	2.03	2.25	2.34	2.40	**	S	0.08	0.16
		Mean	2.95	2.69	2.71	2.31	2.22	2.52	2.55	2.57	***	N.S.	0.21	--
9.	Weight of sesamum seed/plant	40	3.4	2.8	2.7	2.4	2.1	2.7	2.8	2.7	*	S	0.28	0.57
		60	2.8	2.3	2.2	1.8	1.5	2.1	2.1	2.1	**	S	0.15	0.31
		Mean	3.1	2.4	2.5	2.1	1.8	2.4	2.5	2.4	***	N.S.	0.39	--
10.	No.of pods/plant	40	23.3	23.0	31.3	20.6	24.0	17.0	22.3	23.1	*	N.S.	3.70	--
		60	22.6	21.3	24.0	16.3	21.6	22.3	22.3	21.5	**	N.S.	2.00	--
		Mean	23.0	22.1	27.6	18.5	22.8	19.6	22.3	22.3	***	N.S.	5.23	--
11.	Weight of pods/ plant(gms.)	40	5.9	5.4	5.3	4.0	3.8	5.5	5.2	5.1	*	S	0.44	0.91
		60	5.4	4.5	4.4	3.5	3.6	4.6	4.3	4.4	**	S	0.23	0.47
		Mean	5.6	4.9	4.8	3.8	3.7	5.1	4.7	4.8	***	N.S.	0.62	--
12.	Percent of seed to pods (by weight)	40	61.6	52.0	53.0	52.3	49.6	51.0	50.6	54.8	*	N.S.	3.25	--
		60	52.3	49.3	46.0	46.3	46.3	46.0	47.6	47.7	**	S	1.69	3.50
		Mean	57.0	50.6	49.5	49.3	48.0	48.5	49.1	51.3	***	N.S.	4.60	--

A = Adjacent to intercrop row
B = Away from intercrop row

* = Crop treatments
** = Soil moisture regimes
*** = Crop treatments x soil moisture regimes

S = Significant
N.S. = Not significant.

Fig. 4 : CUMULATIVE HEIGHT OF THE CROP



4.1.2 INTER CROPS (Subsidiary crops)

4.1.2.1 JOWAR: The data pertaining to jowar crop characters are presented in table (8).

(Table 8 is given on page 56)

Jowar crop recorded 65 cms. height at the age of 43 days, with increased to 83 cms. at the age of 72 days (Fig. 4). None of the characters listed in the Table (8) recorded significant differences due to combinations or soil moisture regimes. However, the trends indicated that jowar as an inter crop, in groundnut was benefited by increased dry matter production/plant, and grain yield/plant. As an inter crop in korra, jowar recorded slight reduction in grain yield/plant, compared to pure jowar crop.

4.1.2.2 BAJRA: The data pertaining to bajra crop characters are presented in table (9).

(Table 9 is given on page 57)

Bajra crop recorded 42 cms. height at the age of 30 days which increased to 83 cms. at the age of 72 days (Fig.4). Only one character i.e., grain yield/plant, recorded significant differences among treatments. Bajra, as an inter-crop in sesamum recorded significantly lower yields as compared to that in korra and was on par with pure bajra crop. Differences in other characters were not significant.

The effect of soil moisture regimes on various crop characters were also not significant, however greater contribution from the yield characters was recorded in 40% A.S.M.D. regime as compared to 60% A.S.M.D. regime.

Contd...58

Table (8)

JOWAR CROP CHARACTERS

Sl No	Character	Soil moisture regime (% ASM depleted)	Pure jowar crop	Jowar grown as an inter crop in			Mean	Vari-ants	F-Test	S.E.	C.D.at 5%
				Ground-nut	korra	Sesamum					
1.	Plant height (in cms.)	40	93.4	96.9	92.1	91.1	93.4	*	N.S.	7.64	--
		60	95.2	92.2	87.3	96.2	92.7	**	N.S.	5.40	--
		Mean	94.3	94.6	89.7	93.7	93.1	***	N.S.	10.80	--
2.	No.of leaves/plant	40	7.3	5.0	5.0	5.0	5.6	--	--	--	--
		60	7.0	4.5	5.0	5.0	5.4	--	--	--	--
		Mean	7.2	4.8	5.0	5.0	5.5	--	--	--	--
3.	Days to 50% bloom	40	44	44	44	44	44	--	--	--	--
		60	44	44	44	44	44	--	--	--	--
		Mean	44	44	44	44	44	--	--	--	--
4.	Days to maturity	40	110	109	109	109	109	--	--	--	--
		60	109	109	109	109	109	--	--	--	--
		Mean	110	109	109	109	109	--	--	--	--
5.	Dry matter production in gms./plant	40	40.1	65.6	64.0	48.0	51.3	*	N.S.	10.10	--
		60	47.4	64.0	40.1	59.1	52.7	**	N.S.	7.14	--
		Mean	43.8	64.8	52.1	53.6	52.0	***	N.S.	14.30	--
6.	Grain wt.in gms./ plant.	40	38	47	37	42	40.9	*	N.S.	9.34	--
		60	33	41	26	34	33.7	**	N.S.	6.61	--
		Mean	35	44	31	38	37.3	***	N.S.	13.22	--
7.	Test weight in gms./1000 seed	40	24.31	24.69	25.46	22.85	24.33	*	N.S.	1.80	--
		60	21.58	21.00	24.72	24.40	22.92	**	N.S.	1.30	--
		Mean	22.94	22.85	25.09	23.63	23.63	***	N.S.	2.53	--

* = Crop treatments
** = Soil moisture regimes
*** = Crop treatments x soil moisture regimes

S = Significant
N.S. = Not significant.

Table (9)

BAJRA CROP CHARACTERS

Sl No	Character	Soil moisture regime (% ASM depleted)	Pure bajra crop	Bajra grown as an inter crop in groundnut	Bajra grown as an inter crop in korra	Bajra grown as an inter crop in sesamum	Mean	Vari-ants	F-Test	S.E.	C.D.at 5%
1.	Plant height (in cms.)	40	101.1	85.3	86.0	103.3	93.9	*	N.S.	6.20	--
		60	97.4	90.6	84.3	74.9	86.8	**	N.S.	4.38	--
		Mean	99.2	88.0	85.2	89.1	90.4	***	N.S.	8.77	--
2.	No.of leaves/ tiller.	40	7.6	6.0	6.0	5.0	6.2	--	--	--	--
		60	6.3	6.0	5.5	5.5	5.8	--	--	--	--
		Mean	6.9	6.0	5.8	5.3	6.0	--	--	--	--
3.	No.of tillers/hill	40	5.3	5.5	6.0	5.0	5.5	--	--	--	--
		60	3.3	4.5	4.5	4.0	4.1	--	--	--	--
		Mean	4.3	5.0	5.3	4.5	4.8	--	--	--	--
4.	Effective tillers/ hill	40	3.2	4.6	3.7	3.8	3.8	*	N.S.	1.25	--
		60	2.5	4.0	3.9	3.8	3.6	**	N.S.	0.88	--
		Mean	2.9	4.3	3.8	3.9	3.7	***	N.S.	1.77	--
5.	Days to 50% bloom	40	40	39	40	40	40	--	--	--	--
		60	40	39	40	40	40	--	--	--	--
		Mean	40	39	40	40	40	--	--	--	--
6.	Days to maturity	40	103	103	104	104	104	--	--	--	--
		60	103	103	104	104	104	--	--	--	--
		Mean	103	103	104	104	104	--	--	--	--
7.	Dry matter production/hillt (gms.)	40	69.6	69.5	68.2	71.9	69.8	*	N.S.	4.62	--
		60	63.8	66.8	59.9	66.5	54.2	**	N.S.	3.26	--
		Mean	66.7	68.1	64.1	69.2	62.0	***	N.S.	6.53	--
8.	Test weight gms./ 1000 seed	40	6.56	6.28	5.94	6.11	6.22	*	N.S.	0.77	--
		60	5.61	5.69	5.31	5.48	5.52	**	N.S.	0.54	--
		Mean	6.09	5.98	5.63	5.80	5.87	***	N.S.	1.06	--
9.	Grain wt.gms./hill	40	19.38	20.36	21.35	16.74	19.46	*	S	1.43	3.07
		60	17.09	17.50	19.80	15.53	17.51	**	N.S.	1.02	--
		Mean	18.23	18.94	20.61	16.13	18.49	***	N.S.	2.04	--

* = Crop treatments

** = Soil moisture regimes

*** = Crop treatments x soil moisture regimes.

S = Significant

N.S. = Not significant

4.1.2.3 CASTOR : The data pertaining to castor crop characters are presented in table (10).

(Table 10 is given on page 59)

Significant differences were recorded in characters like, pod yield/plant and percent of seed to pods. As an inter crop in groundnut, castor recorded significantly higher pod yield/ plant (31.5 gms.), compared to other treatments (16 to 19.5 gms.). Percentage of seed to pods, of castor grown as an inter crop in korra (64.5%), was significantly better, compared to pure castor (52.6%). As an inter crop in groundnut, castor was benefited, by increased dry matter production/plant, test weight and number of pods/plant, compared to pure crop, though the differences were not significant.

Percent of seed to pods, increased significantly in castor in 40% A.S.M.D. regime (63.2%) compared to 60% A.S.M.D. regime (48.2%).

4.2 PLANT SPREAD

The fig.(5) represents the plant spread, in between rows, at 30 days of age.

It was observed that bajra crop had maximum plant spread compared to jowar and castor. Groundnut crop was much benefited by castor intercrop, as castor crop height and minimum spread, acted like a shelter belt which did not interfere in the supply of light to groundnut crop. Similar was the effect on sesamum. In case of korra crop, its height was more than castor crop in the initial stages. Bajra crop provided shade, on one row of

Contd...61

Table (10)

CASTOR CROP CHARACTERS

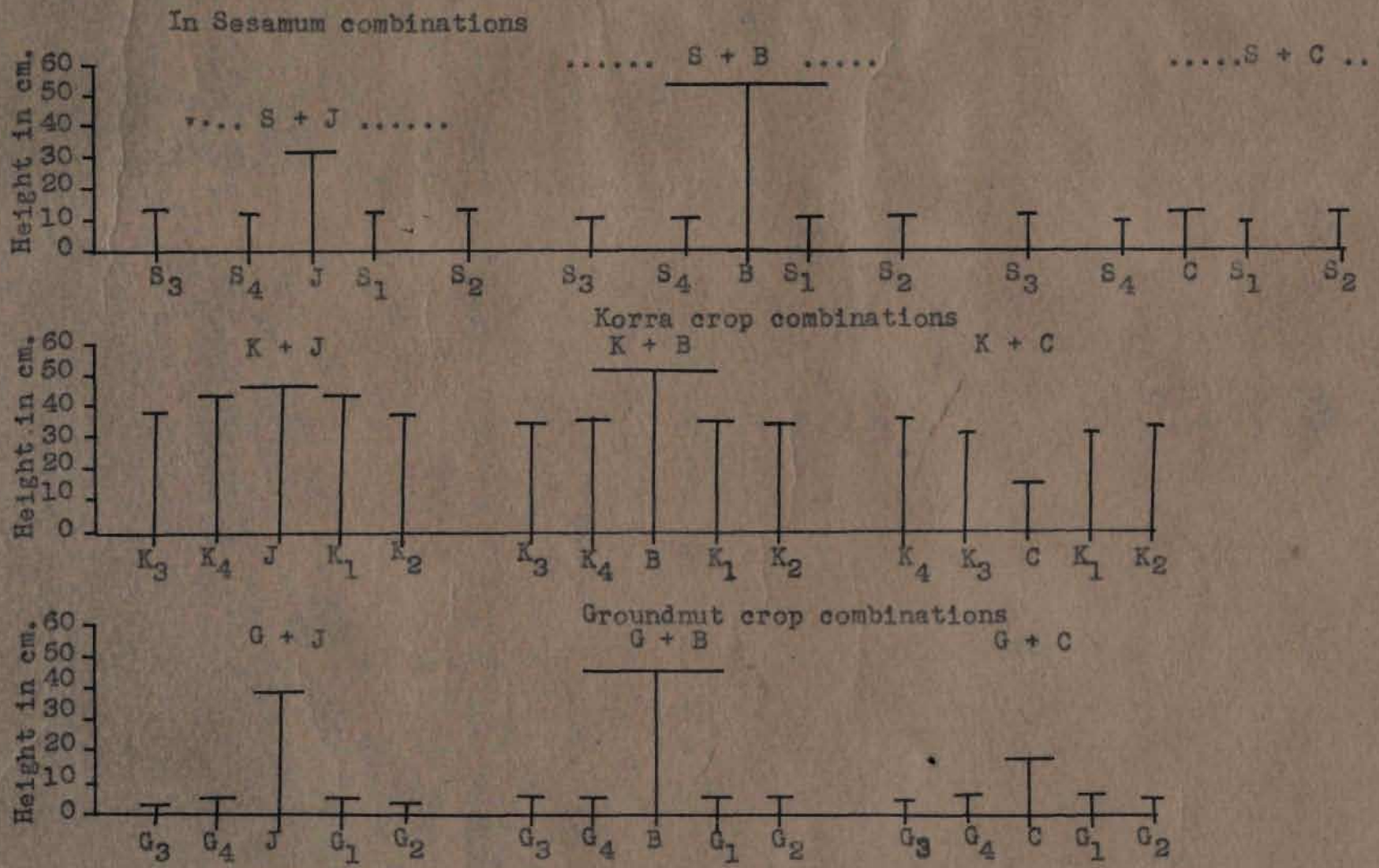
Sl No	Character	Soil moisture regime (% ASM depleted)	Pure castor crop	Castor grown as an inter crop in			Mean	Variants	F-Test	S.E.	C.D.at 5%
				groundnut	korra	sesamum					
1.	Plant height (in cms.)	40	81.2	73.1	70.6	73.0	74.5	*	N.S	8.73	--
		60	67.6	65.6	76.8	75.6	71.4	**	N.S	6.18	--
		Mean	74.4	69.4	73.7	74.3	73.0	***	N.S	12.40	--
2.	No.of leaves/branch (plant)	40	7.0	7.0	7.0	6.0	6.8	--	--	--	--
		60	7.0	7.0	7.0	5.0	6.5	--	--	--	--
		Mean	7.0	7.0	7.0	5.5	6.7	--	--	--	--
3.	Days to 50% bloom	40	41	40	41	41	41	--	--	--	--
		60	41	40	41	41	41	--	--	--	--
		Mean	41	40	41	41	41	--	--	--	--
4.	Days to maturity	40	124	125	125	125	125	--	--	--	--
		60	125	124	125	124	125	--	--	--	--
		Mean	125	125	125	125	125	--	--	--	--
5.	Dry matter gms./plant	40	48	56	47	40	46	*	N.S.	11.3	--
		60	42	50	48	37	45	**	N.S.	8.0	--
		Mean	45	53	47	39	46	***	N.S.	16.0	--
6.	Test weight gms/100 seed	40	14.57	16.81	14.20	11.68	14.32	*	N.S.	8.33	--
		60	12.92	15.04	15.54	10.47	13.49	**	N.S.	1.35	--
		Mean	13.74	15.92	14.87	11.07	13.90	***	N.S.	2.70	--
7.	No.of pods/plant	40	32	44	30	25	33	*	N.S.	8.33	--
		60	27	45	28	20	30	**	N.S.	5.86	--
		Mean	30	45	29	23	32	***	N.S.	11.80	--
8.	Pods weight gms./plant	40	17	32	19	18	21.5	*	S	4.20	9.01
		60	18	31	20	14	20.7	**	N.S.	2.95	--
		Mean	17.5	31.5	19.5	16.0	21.1	***	N.S.	5.93	--
9.	Percent of seed to pods (by wt.)	40	58.5	63.5	69.3	61.6	63.2	*	S	5.70	12.23
		60	46.7	60.8	59.7	25.5	48.2	**	N.S.	4.05	8.68
		Mean	52.6	62.2	64.5	43.5	55.7	***	N.S.	8.08	--

* = Crop treatments
** = Soil moisture regimes
*** = Crop treatments x soil moisture regimes

S = Significant
N.S. = Not significant

Fig. 5 : PLANT SPREAD 30 DAYS AFTER SOWING IN DIFFERENT TREATMENTS

Scale for row spacing and spread = 1 cm.=22.5 Cm.



main crop on either side. Spread of jowar crop was more than that of castor and less than that of bajra crop.

4.3 Rate of Dry matter Production/unit area ($\frac{1}{2}$ m^2)

The data pertaining to dry matter production are presented in appendix(VII) and fig. (6) as well.

During the first 30 days of crop in 40% A.S.M.D.regime, dry matter production was maximum in jowar on an average (3.0 gms./day), while in castor it was minimum about 0.56 gms./ day. Bajra followed by sesamum crops produced on an average higher rate of dry matter production, for the rest of the grop growth period i.e., from 30th day to harvest. Groundnut crop recorded on an average dry matter production of 0.82 gms. per day till 60th day, thereafter it increased to (2.7 gms./day). On an average castor recorded lowest dry matter production (1.879 gms./day) among all the crops, during the period, 60th day to harvest. Except in jowar, in all other crops dry matter production was at an increasing rate throughout the growth period.

Similar was the trend of all crops, in 60% A.S.M.D. regime and in crop combination treatments.

4.4 GRAIN YIELD IN Kg./ha.

The data related to grain yields are presented in table (11).

(Table 11 is given on page 63)

It was observed that as pure crops the average yield of bajra crop ranged from 42 to 49 q./ha., while that of castor

Contd... 64

Fig. 6 : RATE OF DRY MATTER PRODUCTION IN 0.5 m^2 (gms./day)

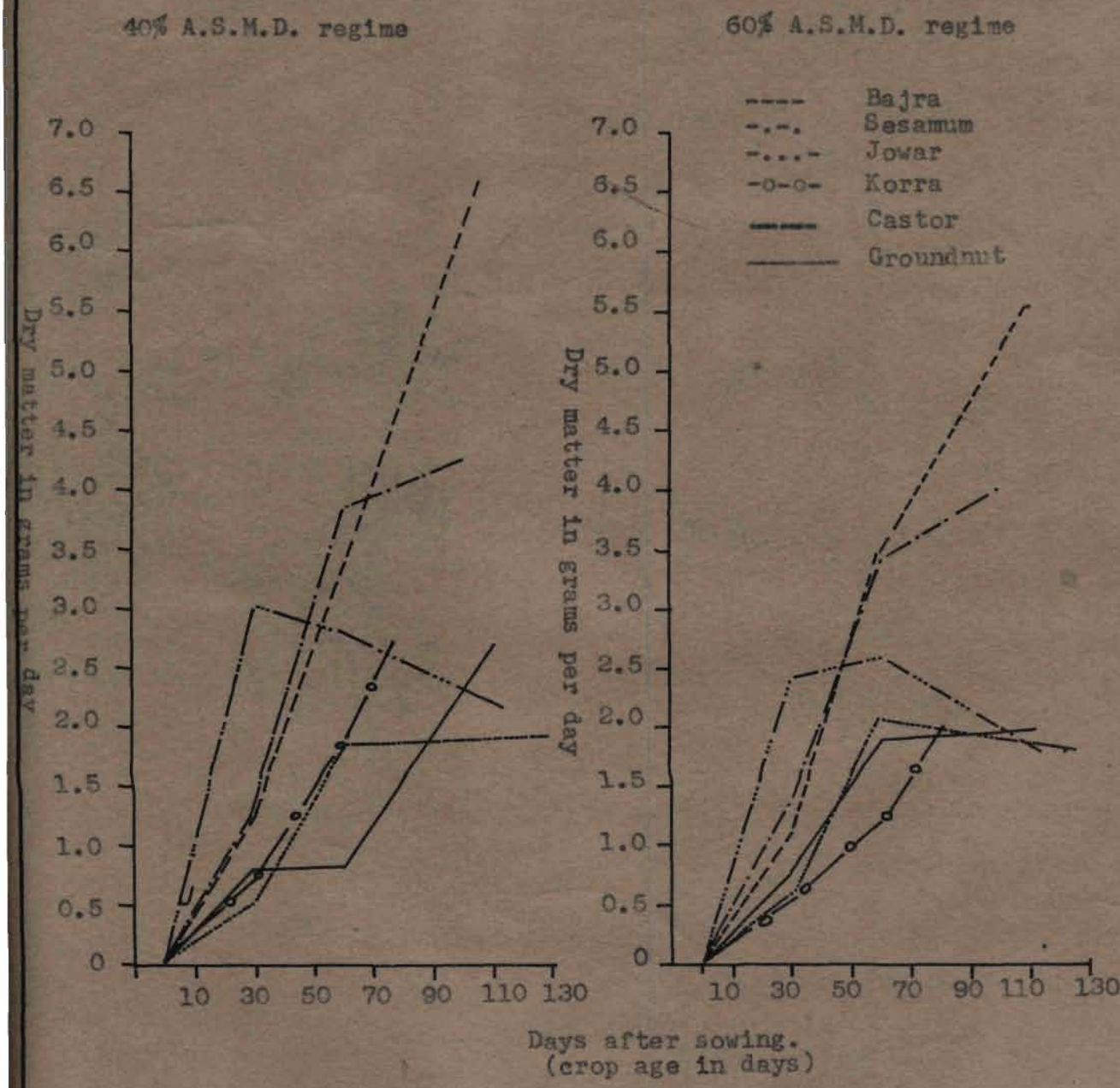


Table (11)

GRAIN YIELD IN Kg./ha. IN DIFFERENT TREATMENTS

Tr. No.	Treatment	Grain yields			Relative percentage of combinations compared to pure crops.		
		Soil moisture regimes			Soil moisture regimes		
		40% depletion	60% depletion	Mean	40% depletion	60% depletion	Mean
1.	Jowar	1930	1531	1730	100	100	100
2.	Groundnut	1693	1534	1613	100	100	100
3.	Bajra	4956	4277	4616	100	100	100
4.	Korra	1280	1278	1279	100	100	100
5.	Sesamum	752	660	706	100	100	100
6.	Castor	637	614	625	100	100	100
7.	Groundnut+Jowar	(930+949)	(634+1068)	(782+1008)	(55 + 49)	(41 + 70)	(48 + 59)
8.	Groundnut+Bajra	(1110+1388)	(761+986)	(935+1187)	(65 + 28)	(50 + 23)	(57 + 26)
9.	Groundnut+Castor	(1348+430)	(1090+356)	(1219+393)	(80 + 69)	(71 + 58)	(75 + 63)
10.	Korra + Jowar	(742+681)	(676+518)	(709+599)	(58 + 35)	(53 + 34)	(56 + 35)
11.	Korra + Bajra	(867+952)	(824+355)	(845+903)	(68 + 19)	(64 + 20)	(66 + 20)
12.	Korra + Castor	(1392+137)	(1205+237)	(1298+187)	(109 + 22)	(94 + 39)	(102 + 30)
13.	Sesamum + Jowar	(516+816)	(323+767)	(420+791)	(67 + 42)	(49 + 50)	(58 + 46)
14.	Sesamum + Bajra	(325+1079)	(323+890)	(324+984)	(43 + 22)	(49 + 21)	(46 + 21)
15.	Sesamum + Castor	(653+139)	(437+60)	(544+100)	(87 + 22)	(66 + 10)	(77 + 16)

The figures that are given in parentheses correspond to maincrop yield plus inter crop (subsidiary crop) yield together in Kgs./ha.

In mixed crop treatment normal value of main crop = 80% (or 85% for sesamum)

In mixed crop treatment normal value of inter crop = 20% (or 15% with sesamum)

from 6.1 to 6.3 q./ha. In general, the yields of groundnut, korra and sesamum crops, decreased with the association of jowar and bajra grown as subsidiary or inter crops. Castor as an intercrop, showed beneficial effect in some combinations, while in others the effect was marginal. All the three inter crops viz., jowar, bajra and castor were benefited by growing as inter crops than as pure crops, on unit area basis.

Compared to pure crop, groundnut and korra occupied only 80% and sesamum 85% of area, in mixed cropped treatments and remaining 20% or 15% as the case may be was occupied by the inter crops. Thus 80 or 85% and 20 or 15% yield of the main and intercrops, compared to their respective pure crop yields, would be the normal pattern. As against this, by growing jowar, bajra and castor as inter crops, the yield levels of main crops were as follows:

	Jowar	Bajra	Castor	Normal
Groundnut ..	48%	57%	75%	80%
Korra ..	56%	66%	102%	80%
and sesamum ..	58%	46%	77%	85%

Similarly for inter crops, when grown in association with groundnut, korra and sesamum the yield level of inter crops were as follows:

	Groundnut	Korra	Sesamum
Jowar ..	59%	35%	46%
Bajra ..	26%	20%	21%
and castor ..	63%	30%	16%
Normal ..	20%	20%	15%

Contd...65

Like the effect of intercrop on main crop, the yield of inter crop was also influenced by the main crop. Castor and jowar crops benefited more than that of bajra, in mixed cropping. Groundnut crop association in castor and jowar was more beneficial than others. It could be the effect of leguminous nature of groundnut crop. This was also observed by Lipman (1912), Wilson (1942) and Reddy et al (1965).

Better yield performance of jowar crop, in mixed cropping, compared to pure crop was also reported by Bodade (1964).

4.5 STRAW YIELDS IN Kg./Ha.

The data pertaining to straw yields are presented in table (12).

(Table 12 is given on page 66)

It was observed that straw yields followed a similar trend, as that of grain, except in groundnut haulms, which increased in castor crop association.

Depressed yields of main crops viz., groundnut, korra and sesamum with jowar and bajra inter crops could be due to more competition for moisture, light and nutrients in mixed cropping.

4.6 MONETARY RETURNS (Rs./ha.)

The data pertaining to gross monetary returns are presented in table (13) and in fig. (7).

(Table 13 is given on page 67)

Contd...69

Table (12)

STRAW YIELD (Kg./ha) IN DIFFERENT TREATMENTS

Tr. No.	Treatment	Straw yield			Relative percentage of combinations compared to pure crops		
		Soil moisture regimes			Soil moisture regimes		
		40% A.S.M.D.	60% A.S.M.D.	Mean	40% A.S.M.D.	60% A.S.M.D.	Mean
1.	Jowar	7049	6350	6699	100	100	100
2.	Groundnut	4255	3175	3715	100	100	100
3.	Bajra	8065	6452	7258	100	100	100
4.	Korra	4065	2858	3461	100	100	100
5.	Sesamum	7684	7303	7493	100	100	100
6.	Castor	5271	4763	5017	100	100	100
7.	Groundnut+Jowar	(2667+1746)	(2667+1778)	(2667+1762)	(64+25)	(84+28)	(74+26)
8.	Groundnut+Bajra	(3175+2604)	(2286+2159)	(2730+2381)	(75+32)	(72+33)	(73+33)
9.	Groundnut+Castor	(3683+3112)	(3493+2413)	(3588+2762)	(87+59)	(110+51)	(98+55)
10.	Korra + Jowar	(2413+1524)	(1842+1429)	(2127+1427)	(59+22)	(66+23)	(62+22)
11.	Korra + Bajra	(2667+2286)	(2413+2223)	(2540+2254)	(66+28)	(84+35)	(76+31)
12.	Korra + Castor	(3810+1842)	(3239+1651)	(3524+1246)	(94+35)	(113+35)	(104+35)
13.	Sesamum+Jowar	(5588+1651)	(5411+1556)	(5499+1603)	(73+23)	(74+25)	(73+24)
14.	Sesamum+Bajra	(5144+2477)	(5207+1905)	(5175+2191)	(67+31)	(71+30)	(69+30)
15.	Sesamum+Castor	(6604+1270)	(4572+1080)	(5588+1175)	(86+24)	(63+21)	(74+22)

The figures that are given in parentheses correspond to maincrop yield plus inter crop (subsidiary crop) yield together in Kgs./ha.

In mixed crop treatment normal value of main crop = 80% (or 85% for sesamum)
In mixed crop treatment normal value of inter crop = 20% (or 15% with sesamum)

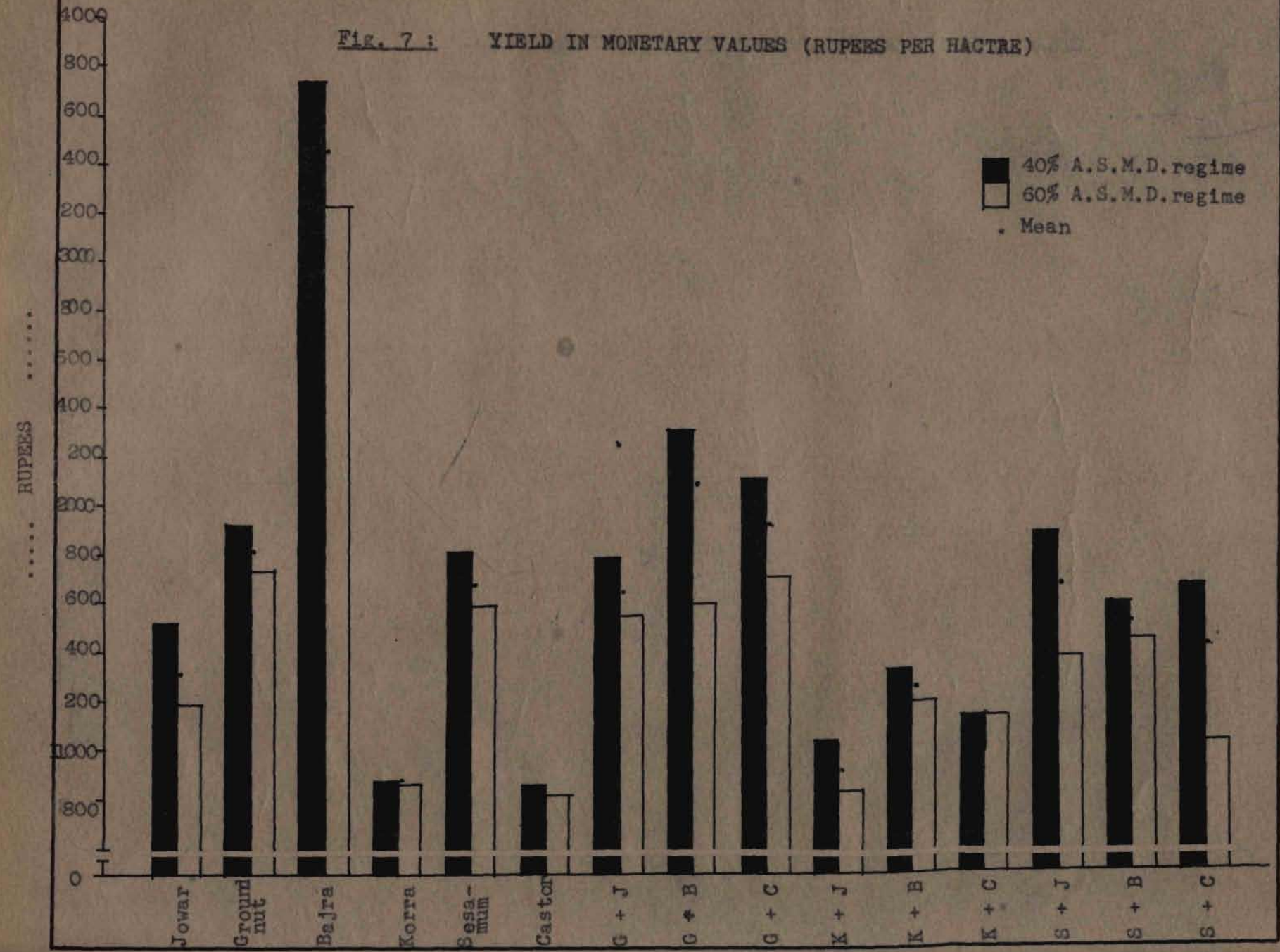
Table (13)

GROSS INCOME IN RUPEES/ha. IN DIFFERENT TREATMENTS

Tr.No.	Treatments	Soil moisture regimes 40% A.S.M.D.	60% A.S.M.D.	Mean
1	Jowar ...	1509.49	1185.11	1347.31
2	Groundnut ...	1916.47	1736.48	1826.48
3	Bajra ...	3729.25	3218.44	3473.92
4	Korra ...	876.13	874.76	875.45
5	Sesamum ...	1810.16	1587.30	1698.74
6	Castor ...	862.95	832.28	847.62
7	Groundnut + Jowar ...	1796.99	1554.19	1675.50
8	Groundnut + Bajra ...	2302.14	1604.49	1953.32
9	Groundnut + Castor ...	2108.75	1717.10	1912.93
10	Korra + Jowar ...	1040.31	842.63	954.81
11	Korra + Bajra ...	1334.21	1208.31	1271.27
12	Korra + Castor ...	1139.60	1146.19	1142.90
13	Sesamum + Jowar ...	1875.62	1377.95	1626.78
14	Sesamum + Bajra ...	1593.82	1448.09	1520.95
15	Sesamum + Castor ...	1760.62	1130.22	1445.42
	Mean ...	1710.43	1432.68	1571.55

Source of variation	F-Test	S.E.	C.D. at 5%
1. Pure crops V/s. combinations	Not significant	451.4	--
2. Within pure crops	Highly significant	451.4	924.47
3. Within ~~inter~~ crop combinations	Not significant	451.4	--
4. Soil moisture regimes	Highly significant	94.8	193.58
5. Regimes x crop combinations	Not significant	367.1	--

Fig. 7 : YIELD IN MONETARY VALUES (RUPEES PER HACTRE)



Bajra as a pure crop fetched (Rs.3474) significantly higher returns, over all other pure crops. Groundnut as a pure crop (Rs.1826) was next in order and was significantly superior to korra (Rs.875), castor (Rs.848), but was on par with sesamum (1699 Rs.) and jowar (Rs.1347) crops grown as pure crops.

The monetary returns in intercropped treatments did not differ significantly. However, the trends indicated that groundnut crop combinations recorded good returns ranging from (Rs.1676 to Rs.1953) followed by sesamum combinations (Rs.1445 to Rs.1627). Returns of korra crop combinations were the lowest. Among the groundnut crop combinations Groundnut + Bajra and groundnut + castor fetched higher returns over pure groundnut crop treatment. Korra crop brought increased returns when grown as mixture than pure crop, but reverse was the case with sesamum.

Significantly higher monetary returns were obtained at 40% A.S.M.D. (Rs.1710) compared to 60% A.S.M.D.(Rs.1433). Interactions between moisture regimes and crop treatments were not significant.

4.7 WATER USE EFFICIENCY

4.7.1: Water use efficiency (Rs./cm. of water). The data related to water use efficiency in terms of Rs/cm. are presented in table (14) and in figure (8).

(Table 14 is given on page 69a)

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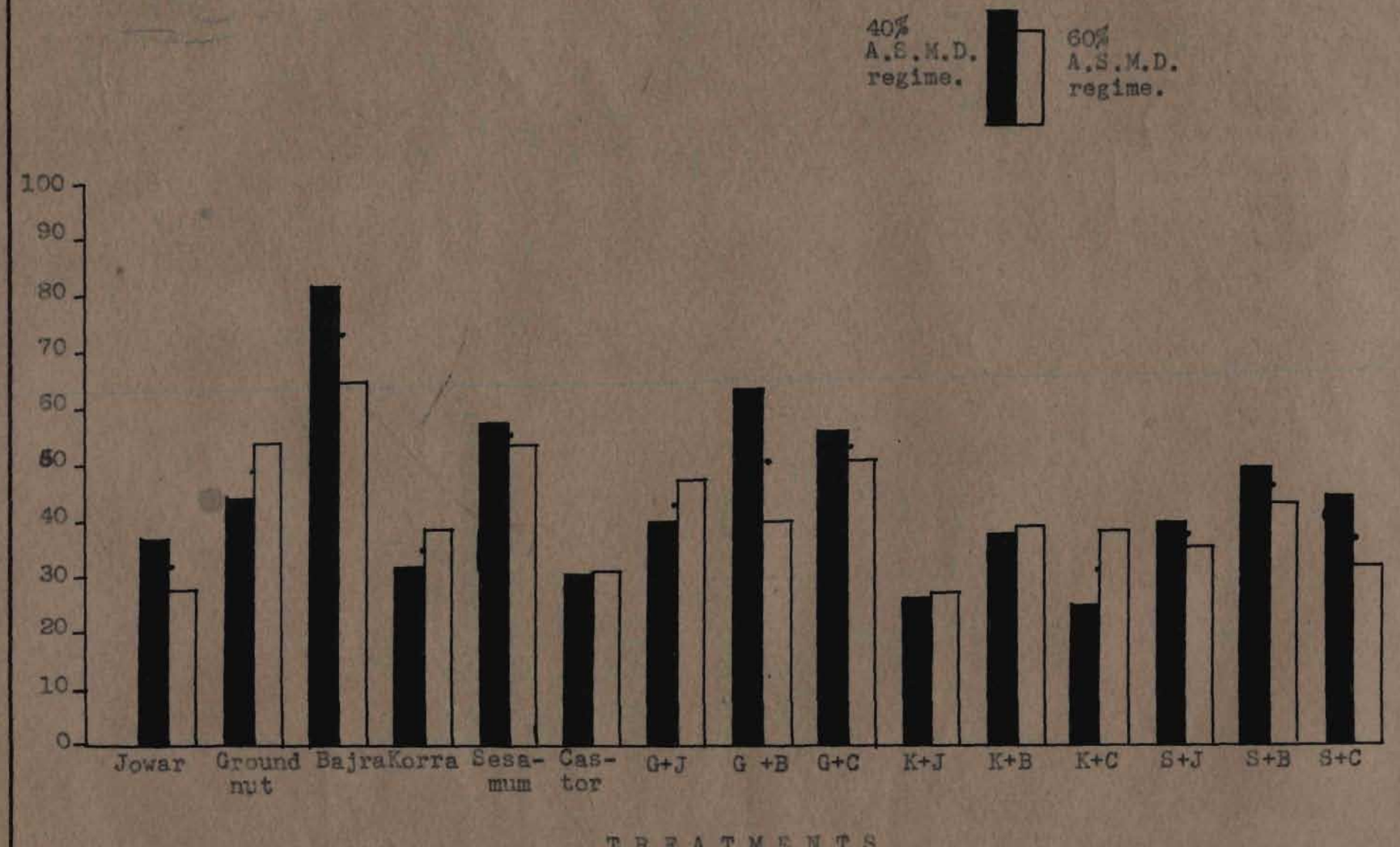
Table (14)

WATER USE EFFICIENCY IN Rs./cm. UNDER VARIOUS TREATMENTS

Tr.No.	Treatments	Soil moisture regime		Mean
		40% A.S.M.D.	60% A.S.M.D.	
1.	Jowar	37.03	28.19	32.61
2.	Groundnut	44.48	53.70	49.09
3.	Bajra	81.35	64.32	72.83
4.	Korra	31.83	38.45	35.14
5.	Sesamum	56.60	53.48	55.04
6.	Castor	30.39	30.74	30.56
7.	Groundnut + Jowar	39.89	46.81	43.35
8.	Groundnut + Bajra	63.34	40.40	51.87
9.	Groundnut + Castor	55.78	50.89	53.34
10.	Korra + Jowar	25.45	26.72	26.13
11.	Korra + Bajra	37.93	38.45	38.19
12.	Korra + Castor	24.58	38.49	31.53
13.	Sesamum + Jowar	39.23	35.66	37.45
14.	Sesamum + Bajra	49.31	43.23	46.28
15.	Sesamum + Castor	44.42	32.22	38.33
	M e a n	44.12	41.45	42.79

Source of variation	F-Test	S.E.	C.D. at 5%
1. Pure crops vs. intercrop combinations	not significant	12.41	--
2. Within pure crops	significant	12.41	26.62
3. Within ~~mixed~~ crop combinations	not significant	12.41	--
4. Soil moisture regimes	not significant	3.68	--
5. Crop-combinations x regimes	not significant	14.26	--

Fig. 8 : WATER USE EFFICIENCY (Rs./cm. of water applied.)



It was observed that among the pure crops the water use efficiency of bajra (Rs.72.83/cm. of water) was significantly higher, compared to sesamum (Rs.55.04/cm. of water), groundnut (Rs.49.09/cm. of water), korra (Rs.35.14 per cm. of water), jowar (Rs.32.61/cm. of water) and castor (Rs.30.56/cm. of water). Among the crop combinations, though the differences were not significant, groundnut + castor treatment recorded highest value (Rs.53.34/cm.) followed by groundnut + bajra treatment (Rs.51.87/cm.), Lowest (Rs.26.13/cm.) water use efficiency was recorded in korra + jowar treatment.

It was observed 40% A.S.M.D. regime (44.12 Rs./cm.) was better over 60% A.S.M.D. regime (41.45 Rs./cm.) though the differences were not significant.

Highest water use efficiency in case of groundnut + castor treatment over pure castor or pure groundnut was indicated probably due to the decrease in potential evaporation exercised by shelter belts, and also due to increased yields by shelter influence. This was also reported by Skidmore and Hagen (1970).

4.7.2 : Water use efficiency (q.of grain/cms.of water):

The data on water use efficiency in terms of q./cm. are presented in table (15) and in figure (9).

(Table 15 is given on page)

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Table (15)

WATER USE EFFICIENCY AMONG THE CROPS (g./cm.water)

Tr.No.	Crop	Soil moisture regime		Mean
		40% A.S.M.D.	60% A.S.M.D.	
1	Jowar	0.48	0.37	0.425
2	Groundnut	0.40	0.48	0.435
3	Bajra	1.01	0.86	0.975
4	Korra	0.47	0.53	0.500
5	Sesamum	0.24	0.22	0.230
6	Castor	0.23	0.23	0.230
	Mean	0.49	0.45	0.470

Fig.9: WATER USE EFFICIENCY IN DIFFERENT CROPS
(Grain in q per cm. of water)

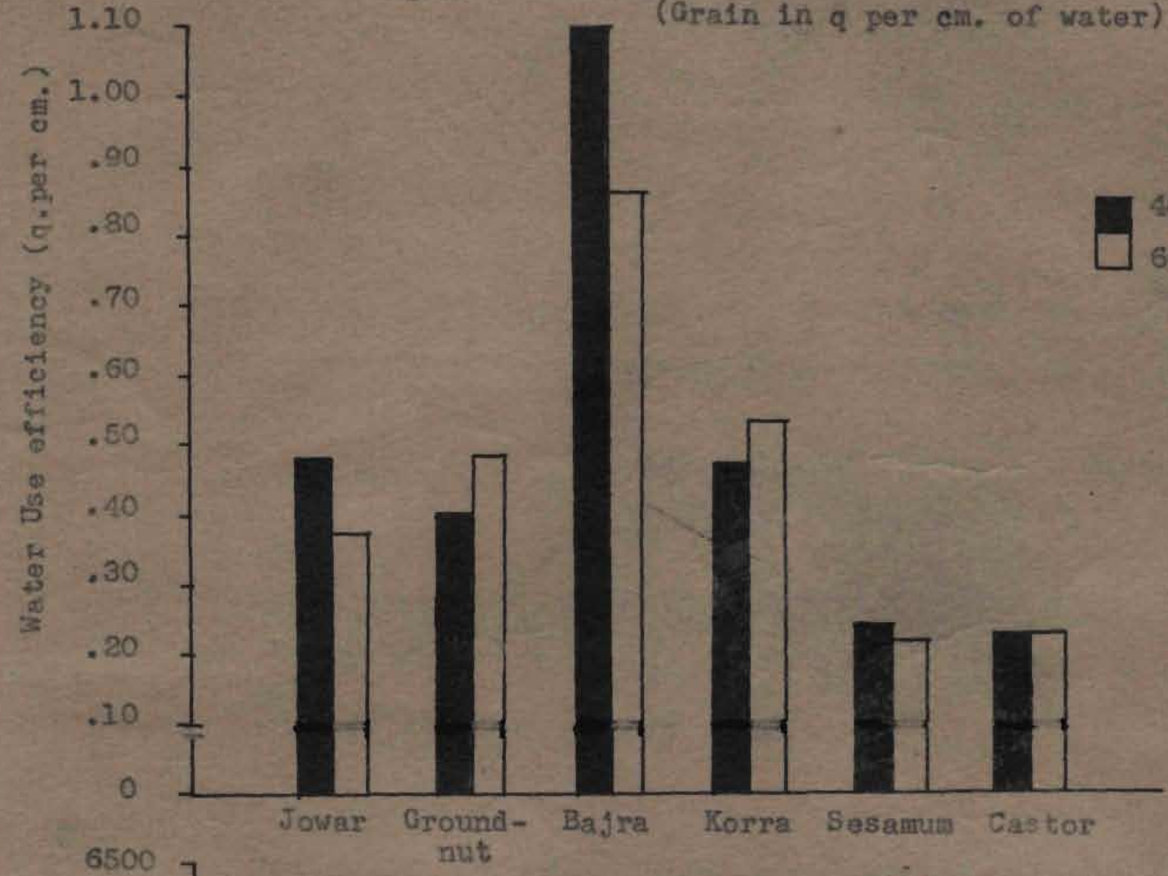
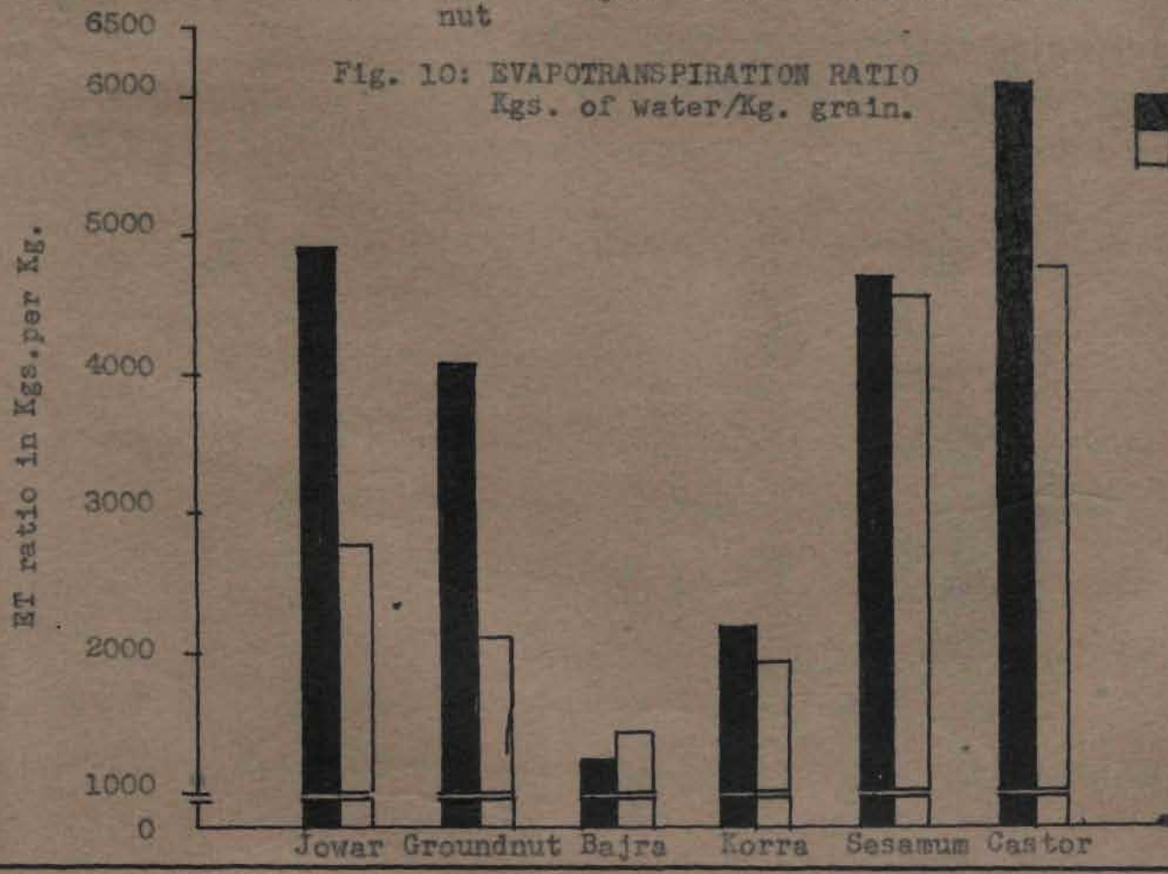


Fig. 10: EVAPOTRANSPIRATION RATIO
Kgs. of water/Kg. grain.



CROPS.

It was observed that bajra crop recorded maximum water use efficiency (0.98 q.cm.) compared to castor, korra (0.50 q./cm.), groundnut (0.44 q./cm.), jowar (0.43 q./cm.) sesamum (0.23 q.cm.).

Surajbhan and Misra (1970[b]) reported that, water use efficiency of groundnut was 0.43 q./cm., when its total water use was 370 mm./ha.

4.8 EVAPOTRANSPIRATION RATIO

4.8.1 : Evapotranspiration ratio (lit. of water used per rupee of economic produce).

The data related to Et. ratio (lit./rupee) are presented in table (16).

(Table 16 is given on page 74)

It was observed that bajra as a pure crop, required 1766 lit. of water as compared to 4904 liters of water, required for korra + jowar combination, to produce one rupee worth economic produce. Among the pure crops jowar recorded highest Et. ratio (4880 Lit.) compared to the lowest Et. ratio of bajra (1766 lit.). Among the crop combinations, korra + jowar recorded the highest Et. ratio and groundnut + castor (1948 lit. per rupee) the lowest. Higher Et. ratio was observed in 40% A.S.M.D. as compared to 60% A.S.M.D.

4.8.2: Et. ratio (Kg. of water/kg. of economic product).

The data on Et. ratio in terms of Kgs. of water/Kg. of economic produce are presented in figure (10) and in table (17).

(Table 17 is given on page 75)

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Table (16)

EVAPOTRANSPIRATION RATIO (Litres/Rupee production)

Sl.No.	Treatments	Soil moisture regimes		Mean
		40% A.S.M.D.	60% A.S.M.D.	
1	Jowar	6150	3611	4881
2	Groundnut	3588	1879	2734
3	Bajra	1607	1924	1766
4	Korra	3161	2675	2918
5	Sesamum	1947	1907	1927
6	Castor	4486	3538	4012
7	Groundnut + Jowar	2759	2129	2444
8	Groundnut + Bajra	2147	2740	2444
9	Groundnut + Castor	1797	2099	1948
10	Korra + Jowar	6064	3744	4904
11	Korra + Bajra	2682	2614	2648
12	Korra + Castor	4407	3698	4053
13	Sesamum + Jowar	3866	4317	4092
14	Sesamum + Bajra	2848	2402	2625
15	Sesamum + Castor	2254	3131	2693
	Mean	3318	2827	3073

Table (17)

EVAPOTRANSPIRATION RATIO AMONG THE CROPS

(Kgs. of Water/ Kg. grain)

Tr.No.	Crop	Soil moisture regime		Mean
		40% A.S.M.D.	60% A.S.M.D.	
1	Jowar	4809	2782	3795
2	Groundnut	4067	2126	3097
3	Bajra	1209	1448	1328
4	Korra	2167	1931	2049
5	Sesamum	4689	4590	4640
6	Castor	6078	4789	5433
	Mean	3837	2944	3391

It was observed that castor required maximum water (5433 Kgs.) followed by sesamum (4640 Kgs.) to produce on Kg. of economic produce. Lowest Et. ratio was observed in bajra (1328 Kgs. of water/Kg. of grain). Excepting bajra, all other crops required more water in 40% A.S.M.D. as compared to 60% A.S.M.D. to produce each Kg. of economic produce.

4.9 EVAPO-TRANSPIRATION

4.9.1 TOTAL Et. AND PER DAY Et.

Data related to total Et. and per day Et. are presented in tables (18 and 19) and in figures (11 and 12).

(Tables 18 and 19 are given on pages 77 and 78)

Though significant differences existed among the pure crops for total water use, no significant variation was recorded in Et./day. Such observation was also reported by Laxminarayana and Reddy (1969). Among the crops studied, castor showed significantly higher water (381 mm) requirement due to its longer duration, but per day water use recorded was minimum (3.02 mm.). Bajra crop with its highest rate of Et.(3.37 mm./day) recorded 358 mm. total water use. Korra crop required a lower amount of total water (250 mm.), due to its shorter duration, per day Et. recorded being 3.24 mm. Among the pure crops, castor had a significantly higher amount of water use than bajra, sesamum and korra, but was on par with jowar and groundnut.

Among crop combinations, differences were not significant for total water use, but were significant for Et. per day.

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Table (18)

TOTAL WATER USE (in mm) IN DIFFERENT CROP TREATMENTS

Sl.No.	Treatments		Soil moisture regime		Mean
			40% A.S.M.D.	60 A.S.M.D.	
1.	Jowar	...	380.68	355.74	368.21
2.	Groundnut	...	391.08	331.87	361.72
3.	Bajra	...	366.40	349.68	358.04
4.	Korra	...	268.27	231.34	249.80
5.	Sesamum	...	358.16	316.58	337.37
6.	Castor	...	412.44	350.35	381.39
7.	Groundnut + Jowar	...	378.11	333.72	355.91
8.	Groundnut + Bajra	...	363.55	323.01	343.28
9.	Groundnut + Castor	...	381.11	337.14	359.12
10.	Korra + Jowar	...	375.49	339.99	357.74
11.	Korra + Bajra	...	358.78	335.47	347.12
12.	Korra + Castor	...	371.70	348.07	359.88
13.	Sesamum + Jowar	...	375.11	335.57	355.34
14.	Sesamum + Bajra	...	360.17	339.16	349.64
15.	Sesamum + Castor	...	374.76	344.54	359.65
	MEAN	...	364.39	331.48	347.94

Source of variation	F-Test	S.E.	C.D. at 5%
1. Pure crops V/s. inter crop combinations	highly significant	9.75	20.91
2. Within pure crops.	highly significant	9.75	20.91
3. Within inter crop combinations	not significant	9.75	--
4. Soil moisture regimes	highly significant	4.94	10.53
5. Crop combinations x Regimes	not significant	19.14	--

Table (19)

EVAPOTRANSPIRATION PER DAY (mm.) IN VARIOUS TREATMENTS

Tr. No.	Treatment	Soil moisture regime		Mean
		40% A.S.M.D.	60% A.S.M.D.	
1.	Jowar	3.37	3.14	3.25
2.	Groundnut	3.40	2.88	3.14
3.	Bajra	3.45	3.29	3.37
4.	Korra	3.48	3.00	3.24
5.	Sesamum	3.54	3.13	3.33
6.	Castor	3.27	2.78	3.02
7.	Groundnut + Jowar	3.28	2.89	3.08
8.	Groundnut + Bajra	3.16	2.80	2.98
9.	Groundnut + Castor	3.02	2.67	2.84
10.	Korra + Jowar	3.32	3.00	3.16
11.	Korra + Bajra	3.38	3.16	3.27
12.	Korra + Castor	2.94	2.76	2.85
13.	Sesamum + Jowar	3.32	2.96	3.14
14.	Sesamum + Bajra	3.39	3.19	3.29
15.	Sesamum + Castor	2.97	2.73	2.85
	M E A N	3.29	2.96	3.13

Source of variation	F-Test	S.E.	C.D.at 5%
1. Pure crops Vs/ inter crop combinations	Highly significant	0.125	0.268
2. Within pure crops	Not significant	0.125	--
3. Within ~~intra~~ crop combinations	Significant	0.125	0.268
4. Soil moisture regimes	Highly significant	0.035	0.0746
5. Crop combinations x regimes	Not significant	0.134	--

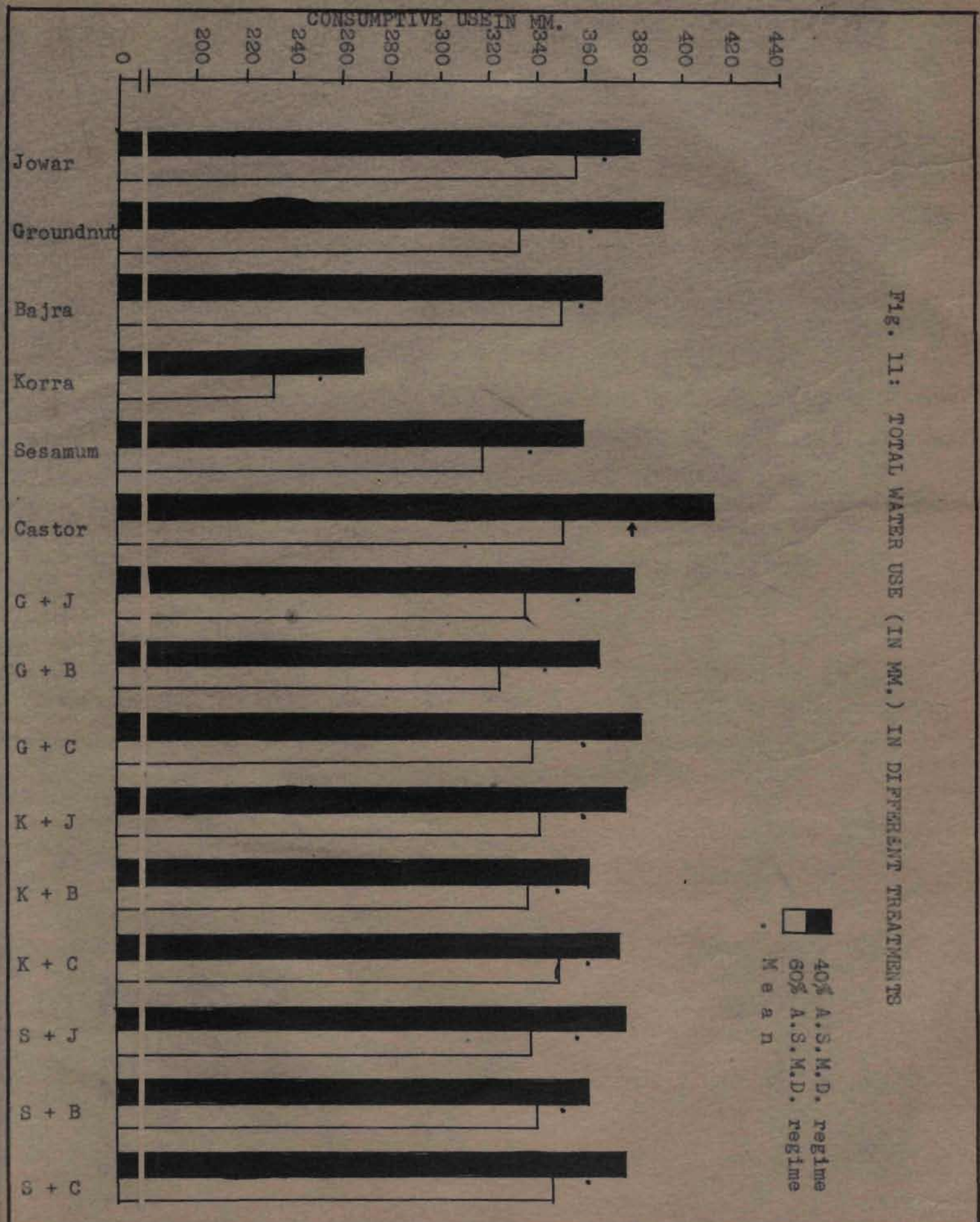
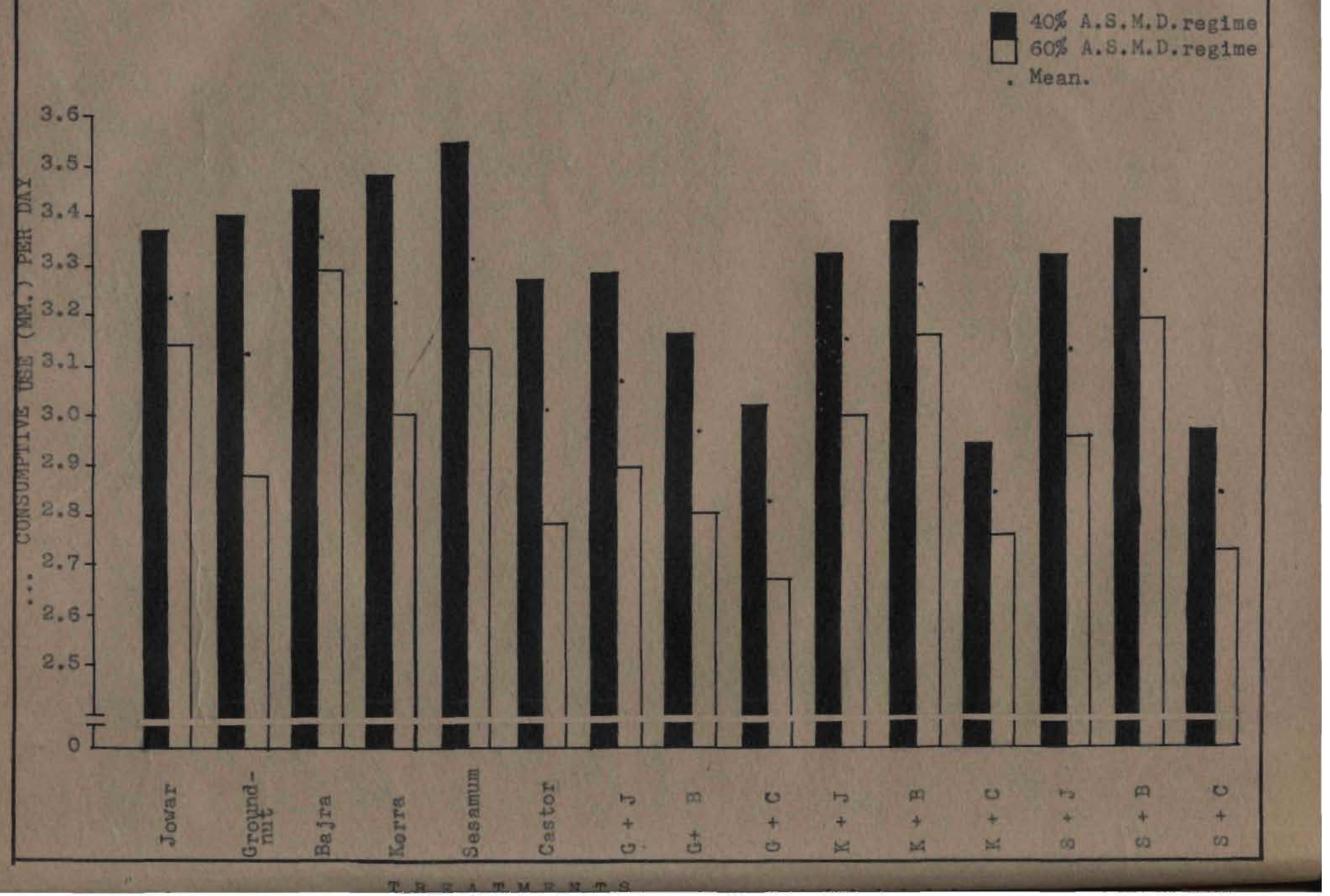


Fig. 11: TOTAL WATER USE (IN MM.) IN DIFFERENT TREATMENTS

Fig.12: EVAPOTRANSPIRATION PER DAY (IN MM.) IN DIFFERENT TREATMENTS



Castor crop combinations recorded higher total water use values, with korra (360 mm.) sesamum (360 mm.) and groundnut (359 mm.) but Et./day was significantly lower in these combinations (2.85, 2.85 and 2.84 mm./day respectively). It could be due to the minishelter effect of castor crop, in reducing Et. as reported by Skidmore and Hagen (1970)[b], Saraf and Dastane (1966).

Significant differences were observed in pure crops vs. combinations, for Et. and also for Et./day. Pure crops recorded lower seasonal water use, compared to combination treatments. Et./day was significantly reduced in mixed cropped treatments, compared to pure crops. This could be due to minishelter effect of taller inter crops on main crops, as reported by Skidmore and Hagen (1970)[b] Saraf and Dastane (1966).

Significantly higher Et. and Et./day was observed in 40% A.S.M.D. regime compared to 60% A.S.M.D. regime. This could be due to higher evaporation losses with frequent irrigations, as reported by de Vries (1959); due to higher transpiration losses caused by the well developed canopy growth, as reported by Singh and Bains (1971); and due to more soil moisture availability causing more Et. losses as reported by Eagleman and Decker (1965), Jain (1967), Laxminarayana and Reddy (1969) and Jain (1970).

4.9.2: Consumptive use during crop growth: The data pertaining to fortnightly consumptive use values are presented in fig.(13) and in table (20).

(Table 20 is given on page 82)

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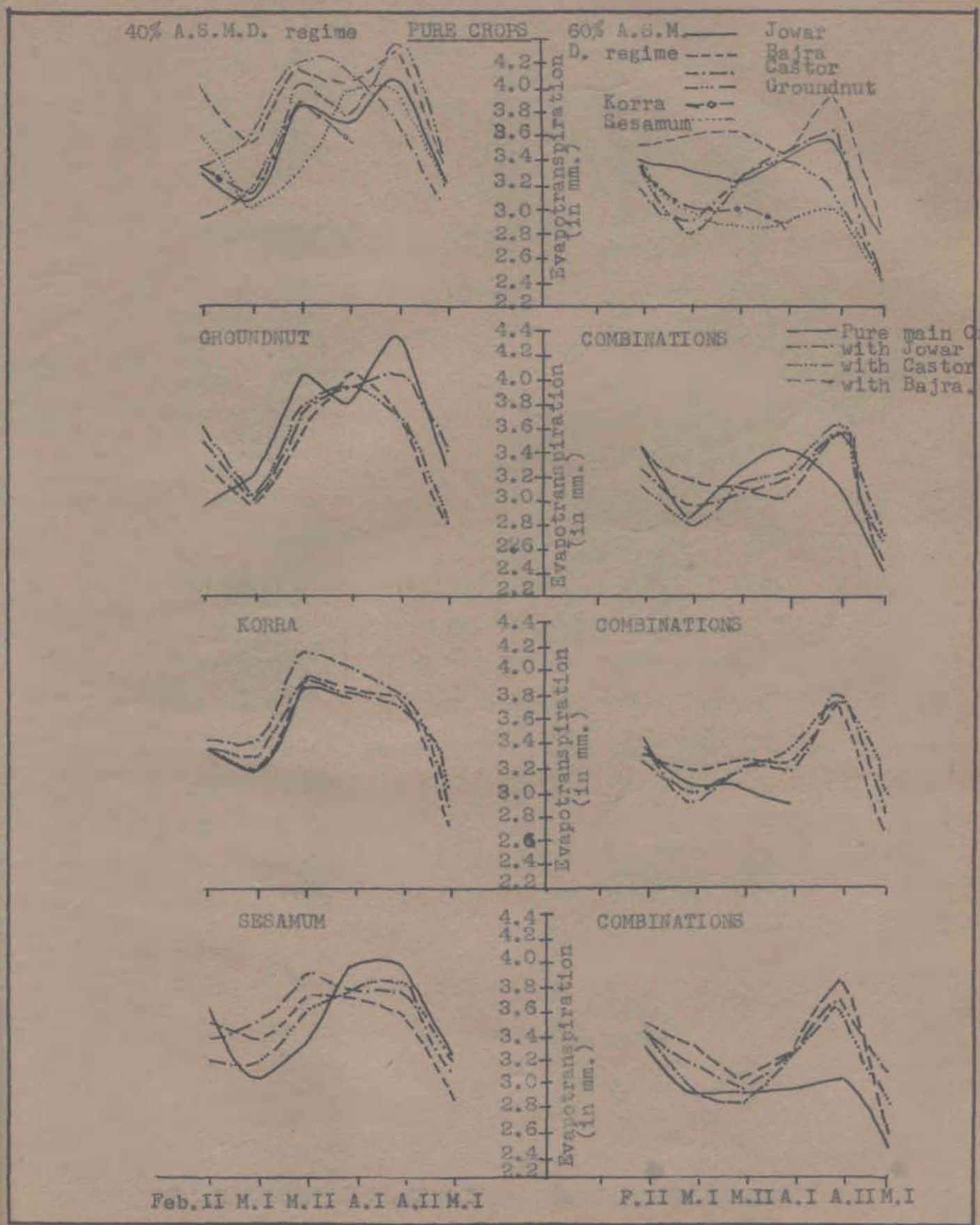
Table (20)

FORTNIGHTLY CONSUMPTIVE USE (in mm.)

Tr. No.	Treatment	Fortnightly Intervals											
		February II		March I		March II		April I		April II		May I	
		40% ASMD	60% ASMD	40% ASMD	60% ASMD	40% ASMD	60% ASMD	40% ASMD	60% ASMD	40% ASMD	60% ASMD	40% ASMD	60% ASMD
1	Jowar	46.38	48.07	46.56	50.52	62.17	51.99	55.55	51.44	62.64	54.15	48.35	41.90
2	Groundnut	41.32	48.07	47.55	42.66	64.43	51.99	56.58	51.44	65.83	47.78	49.42	36.53
3	Bajra	56.50	49.76	53.49	54.48	66.69	58.78	60.69	52.46	64.76	59.46	50.50	41.90
4	Korra	47.23	47.23	47.55	45.58	62.17	48.60	56.58	43.21	CROP HARVESTED			
5	Sesamum	50.60	46.38	46.56	43.59	53.12	46.34	59.67	44.23	59.46	45.65	48.35	36.53
6	Castor	47.23	44.70	53.49	43.59	67.82	51.99	62.75	52.46	56.27	55.21	46.20	36.53
7	Groundnut+Jowar	49.76	45.54	46.56	44.58	59.91	48.60	58.64	47.32	60.52	53.09	50.50	39.75
8	Groundnut+Bajra	46.38	48.07	44.58	47.55	58.78	49.73	60.69	45.26	56.27	53.09	41.90	35.46
9	Groundnut + Castor	50.60	43.85	46.56	41.61	59.91	49.73	58.64	48.35	56.27	54.15	41.90	29.75
10	Korra + Jowar	48.07	48.07	51.51	43.59	66.67	50.36	60.69	47.32	57.33	57.33	40.33	41.90
11	Korra + Bajra	47.23	46.38	47.55	47.55	63.30	51.99	57.61	48.35	57.33	56.27	40.83	39.75
12	Korra + Castor	47.23	45.54	49.53	46.56	62.17	50.86	57.61	50.41	56.27	56.27	44.05	39.75
13	Sesamum+Jowar	47.73	48.07	52.50	43.59	62.17	45.21	56.58	48.35	56.27	55.21	46.20	46.20
14	Sesamum+Bajra	48.91	49.76	50.52	49.53	59.91	48.60	55.55	48.35	53.09	57.33	41.90	38.68
15	Sesamum+Castor	44.70	48.07	47.55	47.55	57.65	47.47	55.55	48.35	57.33	54.15	46.20	41.90

Fig. 13 : DAILY EVAPOTRANSPIRATION (mm./per day) IN DIFFERENT TREATMENTS.



Consumptive use was higher under 40% depletion regime, compared to 60% A.S.M.D. regime, at all the stages of crop growth. In general Et. was highest during second fortnight of March and decreased thereafter. Among the crop combinations, Et. variations were only marginal.

In figure (13), the Et./day during crop growth indicated a general trend of peak water use/day in the second fortnight of March for all the crops. However, the jowar, bajra, groundnut and sesamum there was a second peak during the second fortnight of April. During this period castor crop Et. reduced gradually, while korra was harvested early in the season. During early phases of crop growth, castor utilized maximum water/day, while sesamum recorded minimum Et./day. At later phases of crop growth castor recorded lowest Et./day. With higher moisture stress the peak water use/day, was observed during April second fortnight and during this fortnight bajra crop recorded maximum Et./day, while sesamum recorded lowest Et./day. The crop combinations did not show any particular trend.

4.9.3 : Et./Eo ratio during growth phases:

The data pertaining to Et./Eo ratio are presented in figure (14).

In general the ratio was similar in all the crops and in their combinations. Starting with a high Et./Eo ratio (.64) during second fortnight of February, the rates came down to (0.29) in March second fortnight. Thereafter a peak with

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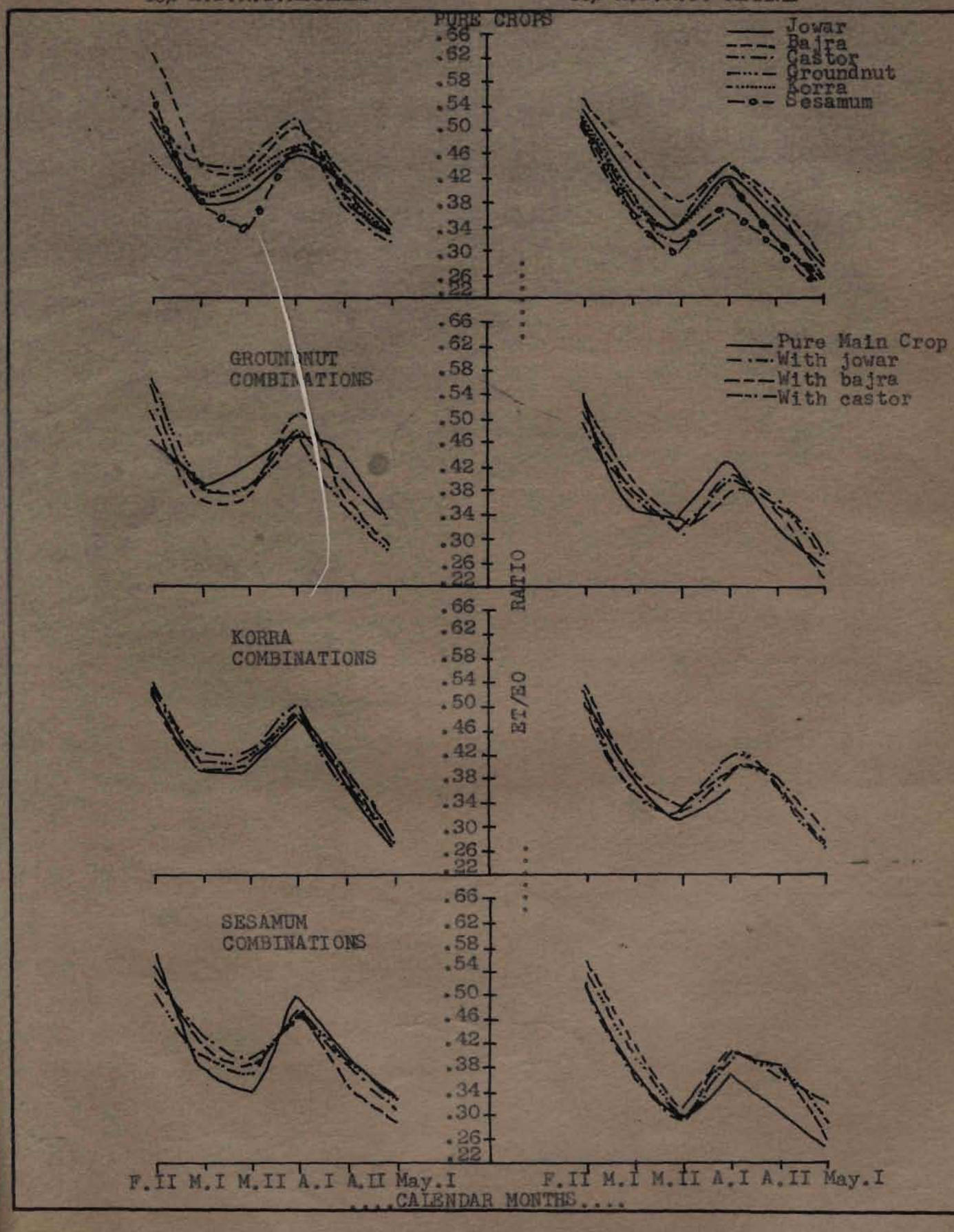
Fig. 14: $\frac{ET}{EO}$ RATIO UNDER DIFFERENT TREATMENTS



0.52 Et./Eo ratio was observed in April first fortnight, which was followed by a steep fall, till the time of harvest.

4.10: CROP COEFFICIENT VALUES

The data pertaining to 'K' values in Blaney and Criddle (1950) formula are presented in table (21 and 22).

(Table 21 and 22 are given on pages 87 and 88 respectively)

All pure crops recorded highest 'K' values (0.53 to 0.67) during February second fortnight. This was due to cloudy weather and 50 mm. rainfall. The 'K' values were lower in May first fortnight ranging from (0.34 to 0.47). Between March and April the 'K' values ranged from 0.47 to 0.59 for jowar from 0.43 to 0.62 for groundnut, from 0.52 to 0.61 for bajra, from 0.42 to 0.55 for korra, from 0.41 to 0.58 for sesamum and from 0.44 to 0.61 for castor crops. The seasonal 'K' values of the crops in order of magnitude were bajra (0.55), jowar, castor and korra crops (0.51), groundnut (0.50) and sesamum (0.49). Higher 'K' values were recorded in 40% A.S.M.D. compared to 60% A.S.M.D. regime.

4.11 : MOISTURE CONTRIBUTION FROM DIFFERENT SOIL DEPTHS

Data on soil moisture extraction from different layers during entire crop cycle are shown in table (23), while periodical depletion from different depths is shown in fig.(15).

(Table 23 is given on page 89)

In general, maximum moisture contribution was observed

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Table (21)

SEASONAL CROP COEFFICIENT

(Blaney-Criddle Formula 'K' value)

Sl.No.	Treatments	Soil moisture regimes		Mean
		40% A.S.M.D.	60% A.S.M.D.	
1	Jowar	0.53	0.49	0.51
2	Groundnut	0.53	0.46	0.50
3	Bajra	0.58	0.52	0.55
4	Korra	0.54	0.47	0.51
5	Sesamum	0.52	0.47	0.49
6	Castor	0.55	0.47	0.51
7	Groundnut + Jowar	0.53	0.46	0.50
8	Groundnut + Bajra	0.51	0.46	0.49
9	Groundnut + Castor	0.52	0.46	0.49
10	Korra + Jowar	0.53	0.48	0.51
11	Korra + Bajra	0.51	0.48	0.50
12	Korra + Castor	0.52	0.48	0.50
13	Sesamum + Jowar	0.53	0.47	0.50
14	Sesamum + Bajra	0.51	0.48	0.50
15	Sesamum + Castor	0.51	0.47	0.49
	Mean	0.53	0.47	0.50

Table (22)

FORTNIGHTLY AND SEASONAL
CROP COEFFICIENT VALUES
(Blaney-Criddle Formula 'K' value)

Sl No	Crop	Fortnightly period 'K' values																			Seasonal 'K' value		
		February.II			March I			March II			April I			April II			May I						
		40% ASMD	60% ASMD	Mean	40% ASMD	60% ASMD	Mean	40% ASMD	60% ASMD	Mean	40% ASMD	60% ASMD	Mean	40% ASMD	60% ASMD	Mean	40% ASMD	60% ASMD	Mean	40% ASMD	60% ASMD	Mean
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1.	Jowar	0.55	0.57	.56	.47	.51	.49	.55	.46	.51	.54	.50	.52	.59	.51	.55	.45	.39	.42	.53	.49	.51
2.	Ground-nut	0.49	.57	.53	.48	.43	.46	.57	.46	.52	.55	.50	.53	.62	.45	.54	.46	.34	.40	.53	.46	.50
3.	Bajra	.67	.59	.63	.54	.55	.55	.59	.52	.56	.59	.51	.55	.61	.56	.59	.47	.39	.43	.58	.52	.55
4.	Korra	.56	.56	.56	.48	.45	.47	.55	.43	.49	.55	.42	.49	. - CROP HARVESTED -						.54	.47	.51
5.	Sesamum	.60	.55	.58	.47	.44	.46	.47	.41	.44	.58	.43	.51	.56	.43	.50	.45	.34	.40	.52	.47	.49
6.	Castor	.56	.53	.55	.54	.44	.49	.66	.46	.53	.61	.51	.56	.53	.52	.53	.43	.34	.39	.55	.47	.51

Table (23)

MOISTURE CONTRIBUTION FROM DIFFERENT SOIL DEPTHS

Tr. No.	Treatment	Soil moisture regimes					
		40% A.S.M.D.			60% A.S.M.D.		
		0-15 cm.	15-30 cm.	30-60 cm.	0-15 cm.	15-30 cm.	30-60 cm.
		(%)	(%)	(%)	(%)	(%)	(%)
1.	Jowar	37.8	23.3	38.9	33.6	24.7	41.7
2.	Groundnut	38.6	27.8	33.6	35.6	28.9	35.5
3.	Bajra	36.5	24.9	38.6	34.1	24.9	41.0
4.	Korra	43.8	26.0	30.2	41.0	27.0	32.0
5.	Sesamum	39.5	27.5	33.0	37.5	28.8	33.7
6.	Castor	36.9	24.2	38.9	35.5	24.3	40.2
7.	*Groundnut + Jowar	39.1	27.3	33.6	37.3	27.4	35.3
7.	**Groundnut + Jowar	37.7	26.9	34.4	35.1	28.7	36.2
8.	*Groundnut + Bajra	39.0	26.2	34.8	36.6	27.9	35.5
8.	**Groundnut + Bajra	38.8	28.8	32.4	36.2	29.9	33.9
9.	*Groundnut + Castor	36.8	27.5	34.9	35.2	27.9	36.9
9.	**Groundnut + Castor	37.8	28.0	34.2	37.2	25.4	37.4
10.	*Korra + Jowar	41.8	27.4	30.8	40.0	27.1	33.5
10.	**Korra + Jowar	38.4	26.5	35.1	34.8	28.5	36.7
11.	*Korra + Bajra	41.8	27.1	31.1	37.2	26.2	36.6
11.	**Korra + Bajra	38.0	25.7	36.3	35.6	26.9	37.5
12.	*Korra + Castor	40.8	27.7	31.5	38.4	28.6	33.0
12.	**Korra + Castor	38.4	26.0	35.6	35.9	27.2	36.9
13.	*Sesamum + Jowar	37.4	27.3	35.3	35.7	27.8	36.5
13.	**Sesamum + Jowar	36.8	27.1	36.1	35.6	28.0	36.4
14.	*Sesamum + Bajra	40.5	27.5	32.0	38.1	28.5	33.4
14.	**Sesamum + Bajra	37.5	27.5	34.9	35.0	27.0	38.0
15.	*Sesamum + Castor	39.9	24.6	35.5	37.1	26.4	36.5
15.	**Sesamum + Castor	38.8	27.2	33.9	36.3	28.7	35.0

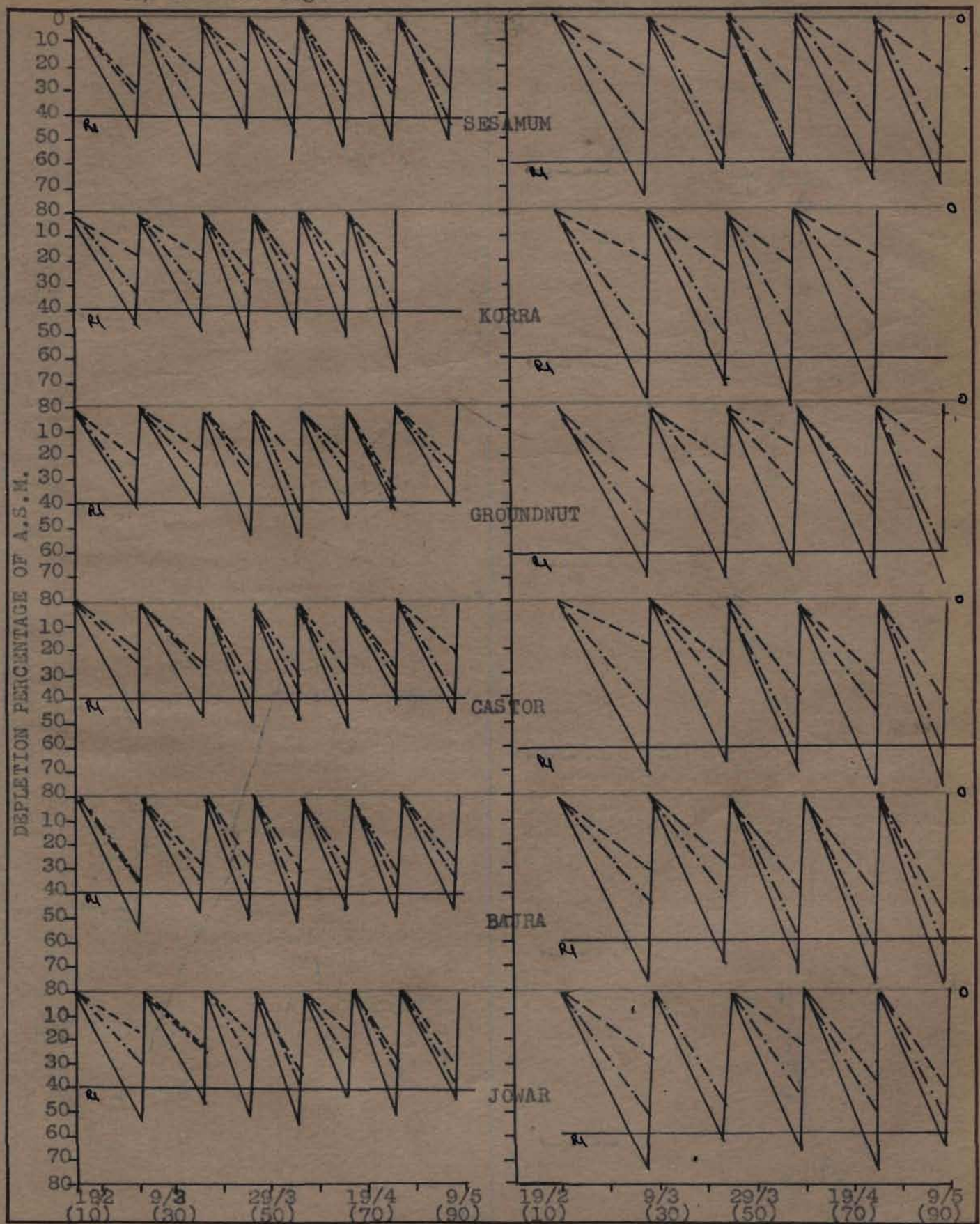
* Sample for soil moisture was drawn in between two main crop rows

** Sample for soil moisture was drawn in between the main crop and intercrop rows.

Fig. 15: AVAILABLE SOIL MOISTURE DEPLETION AT DIFFERENT STAGES OF THE CROP

40% A.S.M.D. regime

60% A.S.M.D. regime



from top 15 cms. layer, followed by that of 15-30 cm. layer. These two layers together contributed, over 60% of the moisture to the crop. The contribution from 30-60 cm. layer ranged from (30.2% to 38.9%), in 40% A.S.M.D. regime and (32.0% to 41.7%) in 60% A.S.M.D. regime. Among the pure crop treatments, jowar, bajra and castor utilized over (38%) of moisture from 30-60 cm. layer while Korra extracted the least amount of water (30.2%) from this layer. Sesamum and groundnut were identical (36%) in this respect. Korra crop extracted the maximum (43.8%) of total requirement from 0-15 cm. layer, while bajra and castor the minimum (36.5% and 36.9%).

In crop combination treatments also moisture extraction trends were similar to that observed in pure crops. In 60% A.S.M.D. extraction was more from lower layers, compared to that in 40% A.S.M.D. regime. In mixed crop treatments, sampling between two main crop rows and main and inter crop rows revealed a combined effect of the two crops and this trend was particularly observed in sampling between main and inter crop rows. Such effects were more prominently observed in korra and sesamum combinations. Similar trends were also observed in the periodical studies on moisture depletion pattern shown in figure (15).

4.12: MICRO-CLIMATIC OBSERVATIONS (RELATIVE HUMIDITY)

The data pertaining to relative humidity observation are presented in figure (16).

It is observed from the figure (16) that only slight variation

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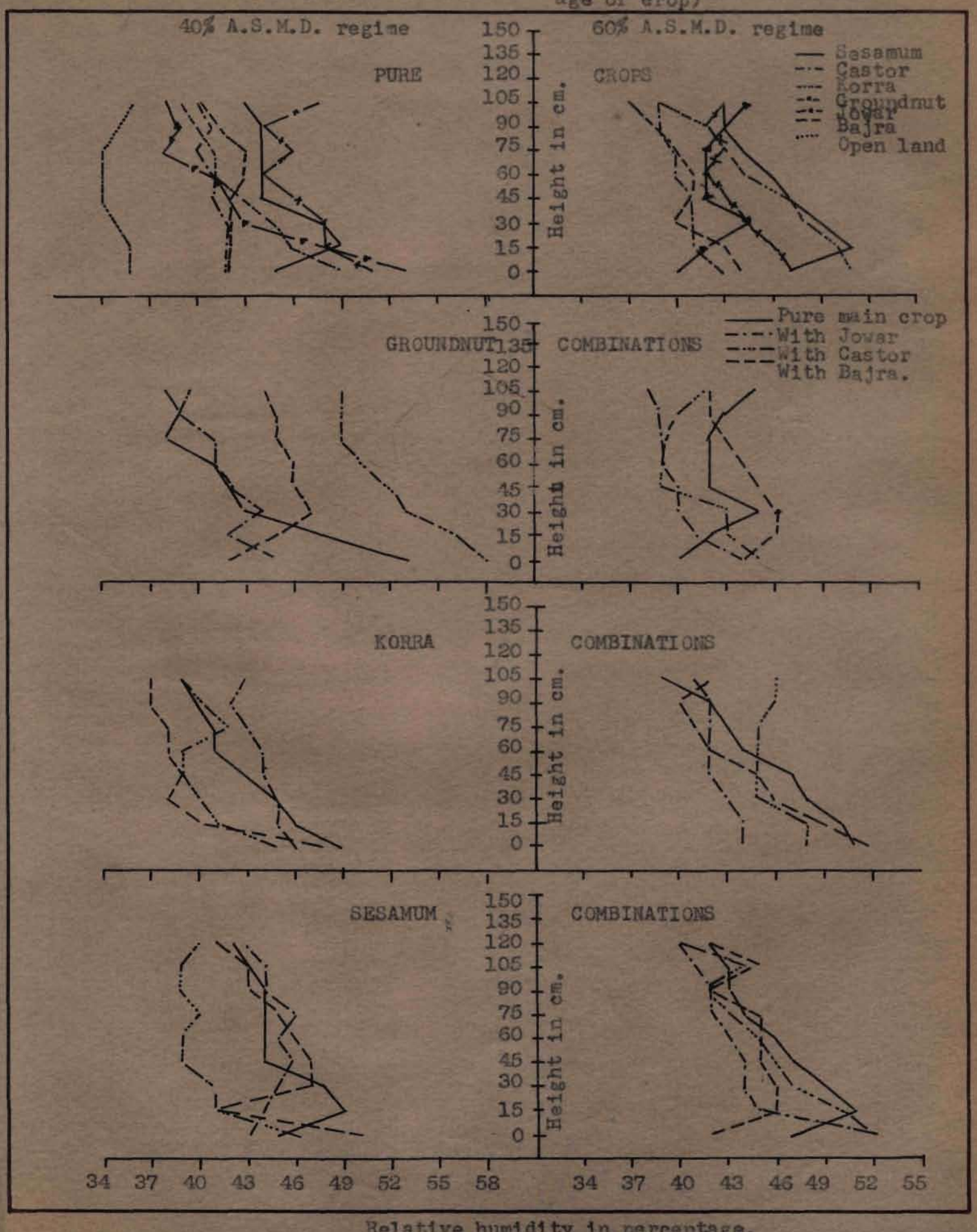
Fig. 16 : RELATIVE HUMIDITY OBSERVATION IN DIFFERENT CROPS
(Average of three readings after 2 months age of crop)



of relative humidity exists in different treatmental plots. Jowar crop in 40% A.S.M.D. regime treatment, recorded maximum relative humidity values as also the pure sesamum in 60% A.S.M.D. regime. Among the combinations groundnut + castor treatment in 40% A.S.M.D. regime recorded maximum relative humidity (49% to 58%) as compared with any other treatment. In each observation, it was observed that as height increased the humidity percentage decreased. In all the treatments the humidity percentage was greater than in the open field. Only slight variation in relative humidity was also observed by Krishnan (1966), Skidmore and Hagen (1970) in their experiments.

4.13 CHEMICAL ANALYSIS

4.13.1 N, P, and K. PERCENTAGES IN PLANT SAMPLES:

Data on N, P, and K percentages in plant samples at the time of harvest are presented in tables (24 to 29)

(Tables 24 to 29 are given on pages 94 to 99 respectively)

In general, in all the crops lower N% was recorded in 40% A.S.M.D. regime as compared to 60% A.S.MD. This could be due to leaching away of N due to frequent irrigations in 40% A.S.M.D. This was also reported by Stone and Trucker (1969). P and K percentages were high in 40% A.S.M.D. as compared to 60% A.S.M.D. Trends in different crops are:

4.13.1.1 GROUNDNUT: Compared to pure crop N% and P% in kernel decreased in mixed crop combination treatments. But K percentage increased with bajra as intercrop. In groundnut haulms N, P and K percentages increased with Bajra and association, compared

Contd...100

Table (24)

CHEMICAL ANALYSIS

N, P, AND K IN GROUNDNUT CROP AT THE TIME OF HARVEST

Sl. No.	Character	Soil moisture regime (% ASM depleted)	Pure groundnut	Groundnut grown along with					
				jowar		bajra		castor	
				A	B	A	B	A	B
			(%)	(%)	(%)	(%)	(%)	(%)	(%)
1.	N in haulms	40	0.68	0.96	0.97	1.21	1.11	0.82	1.04
		60	0.91	1.13	1.42	1.58	1.37	1.18	1.29
		Mean:	0.79	1.04	1.19	1.39	1.24	1.00	1.16
2.	N in kernel	40	4.22	3.77	3.73	3.85	3.86	3.88	3.58
		60	4.29	3.88	3.77	3.92	3.95	3.93	3.74
		Mean:	4.25	3.82	3.75	3.88	3.90	3.90	3.66
3.	P in haulms	40	0.21	0.21	0.21	0.23	0.22	0.20	0.19
		60	0.20	0.22	0.17	0.22	0.22	0.20	0.19
		Mean:	0.21	0.22	0.19	0.23	0.22	0.20	0.19
4.	P in kernel	40	0.40	0.41	0.39	0.45	0.38	0.39	0.38
		60	0.43	0.42	0.38	0.40	0.35	0.40	0.38
		Mean:	0.42	0.42	0.39	0.42	0.37	0.40	0.38
5.	K in haulms	40	0.44	0.42	0.44	0.44	0.46	0.41	0.36
		60	0.44	0.43	0.39	0.45	0.46	0.39	0.34
		Mean:	0.44	0.43	0.42	0.45	0.46	0.40	0.35
6.	K in kernel	40	0.08	0.09	0.09	0.10	0.10	0.08	0.08
		60	0.09	0.09	0.07	0.10	0.09	0.10	0.08
		Mean:	0.09	0.09	0.08	0.10	0.10	0.09	0.08

A = Adjacent to intercrop row
B = Away from intercrop row

Table (25)

N, P AND K IN KORRA PLANT AT THE TIME OF HARVEST

Sl. No.	Character	Soil moisture regime (% ASM depleted	Pure korra	Korra grown along with					
				jowar +		bajra		castor	
				A	B	A	B	A	B
			(%)	(%)	(%)	(%)	(%)	(%)	(%)
1.	N in straw	40	0.87	0.94	0.91	0.99	0.96	0.71	0.84
		60	0.73	0.92	1.06	0.95	1.25	0.76	1.05
		Mean	0.80	0.93	0.98	0.97	1.10	0.73	0.94
2.	N in seed	40	1.70	1.48	1.42	1.79	1.70	1.43	1.42
		60	1.85	1.53	1.49	1.87	1.62	1.55	1.54
		Mean	1.75	1.50	1.45	1.83	1.66	1.49	1.48
3.	P in straw	40	0.35	0.29	0.28	0.38	0.35	0.31	0.29
		60	0.30	0.25	0.23	0.31	0.34	0.27	0.26
		Mean	0.33	0.27	0.26	0.35	0.35	0.29	0.28
4.	P in seed	40	0.67	0.57	0.57	0.53	0.49	0.51	0.46
		60	0.57	0.55	0.53	0.49	0.46	0.46	0.44
		Mean	0.62	0.56	0.55	0.51	0.48	0.49	0.45
5.	K in straw	40	1.49	1.53	1.43	1.39	1.33	1.34	1.27
		60	1.30	1.45	1.38	1.38	1.29	1.42	1.32
		Mean	1.39	1.49	1.40	1.38	1.31	1.38	1.29
6.	K in seed	40	0.34	0.35	0.33	0.34	0.28	0.30	0.31
		60	0.33	0.33	0.29	0.29	0.27	0.28	0.27
		Mean	0.34	0.34	0.31	0.32	0.28	0.29	0.29

A = Adjacent to intercrop row
B = Away from intercrop row

Table (26)

N, P AND K IN SESAMUM PLANT AT THE TIME OF HARVEST

Sl. No.	Character	Soil moisture regime (% ASM depleted	Pure sesamum	Sesamum grown along with					
				jowar		bajra		castor	
				A	B	A	B	A	B
			(%)	(%)	(%)	(%)	(%)	(%)	(%)
1.	N in stalk	40	0.66	0.97	0.72	0.81	0.68	0.89	0.68
		60	0.90	1.10	0.89	1.25	1.11	0.95	0.83
		Mean	0.82	1.04	0.81	1.03	0.90	0.92	0.76
2.	N in seed	40	3.71	3.04	2.88	3.62	3.09	3.94	3.89
		60	4.09	3.39	3.14	3.98	3.33	3.82	4.02
		Mean	3.95	3.22	3.01	3.80	3.21	3.92	3.95
3.	P in stalk	40	0.26	0.31	0.26	0.32	0.28	0.28	0.27
		60	0.23	0.29	0.24	0.32	0.28	0.25	0.23
		Mean	0.25	0.30	0.25	0.32	0.28	0.27	0.25
4.	P in seed	40	0.43	0.39	0.36	0.41	0.38	0.37	0.31
		60	0.36	0.34	0.37	0.36	0.34	0.31	0.26
		Mean	0.40	0.36	0.36	0.39	0.36	0.34	0.29
5.	K in stalk	40	0.55	0.48	0.43	0.49	0.44	0.46	0.42
		60	0.47	0.41	0.35	0.40	0.38	0.39	0.39
		Mean	0.51	0.44	0.39	0.44	0.41	0.42	0.40
6.	K in seed	40	0.16	0.16	0.14	0.14	0.12	0.14	0.12
		60	0.12	0.13	0.12	0.12	0.11	0.12	0.11
		Mean	0.14	0.15	0.13	0.13	0.12	0.13	0.12

A = Adjacent to inter crop row
B = Away from inter crop row

Table (27)

N, P and K IN JOWAR PLANT AT THE TIME OF HARVEST

Sl No	Character	Soil moisture reg. (% ASMD)	Pure jowar	Jowar grown as an inter crop with		
				groundnut	korra	sesamum
			(%)	(%)	(%)	(%)
1.	N in straw	40	0.50	0.69	0.52	0.50
		60	0.79	0.73	0.77	1.02
		Mean	0.65	0.71	0.65	0.76
2.	N in seed	40	1.37	1.52	1.47	0.96
		60	1.63	1.50	1.33	1.09
		Mean	1.50	1.51	1.40	1.02
3.	P in straw	40	0.13	0.11	0.04	0.14
		60	0.05	0.11	0.17	0.15
		Mean	0.09	0.11	0.10	0.14
4.	P in seed	40	0.22	0.20	0.16	0.22
		60	0.19	0.18	0.12	0.17
		Mean	0.21	0.19	0.14	0.20
5.	K in straw	40	1.63	1.46	1.80	1.90
		60	1.43	1.43	1.76	1.76
		Mean	1.53	1.43	1.78	1.83
6.	K in seed	40	1.13	1.23	1.30	1.58
		60	0.99	1.19	1.11	1.13
		Mean:	1.06	1.21	1.21	1.36

Table (28)

N, P and K IN BAJRA PLANT AT THE TIME OF HARVEST

Sl No	Character	Soil moisture regime (% ASM depleted)	Pure bajra	Bajra grown as an inter crop with		
				groundnut	korra	sesamum
			(%)	(%)	(%)	(%)
1.	N in straw	40	0.87	0.64	0.93	0.72
		60	0.94	0.82	0.90	0.82
		Mean	0.91	0.73	0.92	0.77
2.	N in seed	40	1.64	1.65	1.60	1.45
		60	1.90	1.46	2.01	1.75
		Mean	1.77	1.56	1.80	1.60
3.	P in straw	40	0.53	0.58	0.57	0.48
		60	0.48	0.45	0.48	0.46
		Mean	0.51	0.52	0.53	0.47
4.	P in seed	40	0.78	0.79	0.74	0.70
		60	0.67	0.74	0.72	0.68
		Mean	0.73	0.77	0.73	0.69
5.	K in straw	40	1.79	1.73	1.60	1.49
		60	1.64	1.61	1.58	1.46
		Mean	1.72	1.67	1.59	1.48
6.	K in seed	40	1.50	1.46	1.43	1.44
		60	1.44	1.38	1.34	1.35
		Mean	1.47	1.42	1.39	1.40

Table (29)

N, P and K IN CASTOR PLANT AT THE TIME OF HARVEST

Sl No.	Character	Soil moisture regime (% ASM depleted	Pure castor	Castor grown as an inter crop with		
				groundnut	korra	sesamum
			(%)	(%)	(%)	(%)
1.	N in stalk	40	0.90	0.81	0.98	0.89
		60	1.03	0.93	0.99	1.02
		Mean	0.97	0.87	0.99	0.96
2.	N in seed	40	3.21	3.21	3.08	2.97
		60	3.30	3.33	3.26	3.12
		Mean	3.26	3.27	3.17	3.05
3.	P in stalk	40	0.29	0.27	0.30	0.34
		60	0.25	0.27	0.29	0.26
		Mean	0.27	0.27	0.30	0.30
4.	P in seed	40	0.45	0.33	0.40	0.37
		60	0.36	0.34	0.33	0.36
		Mean	0.41	0.34	0.37	0.37
5.	K in stalk	40	0.97	0.98	0.94	0.79
		60	0.88	0.87	0.88	0.77
		Mean	0.93	0.93	0.91	0.78
6.	K in seed	40	0.19	0.17	0.17	0.14
		60	0.18	0.14	0.16	0.13
		Mean	0.19	0.16	0.17	0.14

to all other treatments (Table 24)

4.13.1.2 K O R R A: By intercropping, N, P and K percentages decreased in korra seed compared to pure crop, however, N and P percentages in korra straw increased with bajra as intercrop. As an intercrop jowar increased K% in korra straw. (Table 25).

4.13.1.3 SESAMUM: Mixed cropping in sesamum reduced P and K percentages in seed and K percentage in stalks. Sesamum seed, with castor crop association recorded maximum N percentage, while association with bajra increased the nitrogen percentage in stalks. (Table 26).

4.13.1.4: JOWAR: Sesamum crop association increased N, P and K percentages in jowar straw and K percentage in jowar grain. Korra crop association resulted in reduced P percentage in jowar grain, compared to its pure crop. When jowar was grown as intercrop in sesamum, N percentage in jowar grain was reduced (Table 27).

4.13.1.5: BAJRA: Both seed and straw of bajra crop recorded lower N, P and K percentages with sesamum crop association (Table 28).

4.13.1.6: CASTOR: Castor recorded lower N percentage in stalks and higher N percentage in seed, when grown as intercrop in groundnut. Lower K percentage was recorded in stalk and seed in association of sesamum crop. There was no effect on P percentage due to mixed cropping (Table 29).

4.13.2: N, P and K Uptake (Kg./ha.)

The data pertaining to N, P, K uptake are presented in table (30). (Table 30 is given on page 101

Table (30)

N, P AND K UPTAKE Kgs./ha.

Tr. No.	Treatment	Nitrogen			Phosphorus			Potassium		
		Soil moisture regimes			Soil moisture regimes			Soil moisture regimes		
		40% ASMD	60% ASMD	Mean	40% ASMD	60% ASMD	Mean	40% ASMD	60% ASMD	Mean
1.	Jowar	61.68	75.11	68.39	13.40	6.07	19.73	136.69	105.95	131.32
2.	Groundnut	100.37	94.69	97.53	15.70	12.94	14.32	20.07	15.35	17.71
3.	Bajra	151.43	141.90	146.66	81.39	59.89	70.64	218.70	167.39	193.04
4.	Korra	57.12	44.50	50.81	22.79	12.78	17.78	64.91	41.36	53.13
5.	Sesamum	78.60	92.71	85.65	23.20	19.16	21.18	43.46	35.71	39.58
6.	Castor	67.87	69.31	68.59	18.14	14.11	16.12	52.33	43.01	47.67
7.	Groundnut + Jowar	87.19	87.63	87.41	12.59	11.46	12.02	49.45	49.02	49.23
8.	Groundnut + Bajra	119.12	95.67	107.39	37.59	24.83	31.11	80.69	59.02	69.88
9.	Groundnut + Castor	123.53	119.10	121.31	21.92	18.60	20.26	46.28	35.03	40.65
10.	Korra + Jowar	51.12	46.31	48.71	12.65	11.11	11.88	74.51	58.95	66.73
11.	Korra + Bajra	77.51	78.65	77.78	34.09	28.41	31.25	89.13	80.96	85.04
12.	Korra + Castor	71.35	72.65	72.00	24.18	19.53	21.85	71.31	63.19	67.25
13.	Sesamum + Jowar	67.84	81.57	74.70	21.64	18.83	20.23	70.16	56.98	63.57
14.	Sesamum + Bajra	73.93	97.44	85.68	36.12	32.16	34.14	76.49	60.47	68.48
15.	Sesamum + Castor	72.02	57.44	64.73	24.87	15.20	20.03	40.11	26.68	33.39

Bajra crop recorded higher N, P and K uptake among pure crops. Groundnut treatments in association with bajra and castor intercrops recorded higher N, P and K uptake over pure groundnut crop treatment. However, in groundnut + jowar treatment, reduction in N and P and increase in K uptake was observed, compared to pure groundnut crop. Similar was the trend in korra crop combinations. Sesamum crop recorded lower N, P and K uptake with castor crop association, compared to pure crop of sesamum. In sesamum + Bajra treatment uptake of N was similar to that of pure sesamum but P and K uptake was maximum. In sesamum + ~~bajra~~ jowar treatment uptake of N and P decreased while K uptake increased, compared to pure sesamum crop treatment.

DISCUSSION

C H A P T E R - 5

D I S C U S S I O N

In all experiments having irrigation treatments 'water use efficiency' is the main focal point, because it involves, two important components like 'yield' out-put and 'water' input. When the water use efficiency of different crops are to be compared, the monetary values of yield is used because the physical weights of economic products differ widely.

Mixed cropping, in general, refers to growing two or more crops in the same field, garden or plantation, sharing in common the cultural and other operations of the field, as though these operations were intended for one single crop. According to Garg (1961) mixed cropping has its own advantages, important among them are expectation of higher yields, avoidance of risk, better utilization of manure and water, control of soil erosion, protection against excessive heat and cold winds, improvement in nutritional value of fodders, economic use of land and improvement in soil tilth. Success of mixed cropping depends on the degree of compatability among crops, proper seed rate (plant population) and beneficial plant growth habits.

In the present study a detailed analysis of six crops viz., jowar, bajra, castor, groundnut, korra and sesamum, for growth, yield, and moisture use aspects, indicated wide variations. These are discussed in detail and their compatability evaluated.

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A detailed study of jowar crop showed that this crop recorded a steady increase in height upto 64 days (81 cms.), with a limited canopy compared to other crops (Fig.4). Dry matter production during first 30 days was about 3.0 gms./day which declined to 2.8 gms./day during the period from 30th to 60th day, with a further reduction thereafter (2.2 gm./day) till harvest. Deeper root system enabled this crop to draw nearly 39% of water from 30-60 cm. layer, while the rest was contributed by 0-30 cm. layer. Average yield of the crop was about 1730 Kg./ha. valued at Rs.1347. These yields were, however, low compared to all India results of HYV programme yields of 38.50 q./ha. (Anonymous 1972-'73). With a total Et. of 368 mm. spread over a duration of 113 days, its daily requirement was 3.25 mm./day. The crop recorded 0.43 q.grain/cm. depth of water or fetched Rs.33/cm. depth of water (water use efficiency) and required 3795 Kg. of water/kg. of produce or 4881 lit.water per rupee worth of economic produce (Et.-ratio). Nutrient content at the time of harvest ranged from 1.46% to 2.65% for N and 0.16% to 0.39% for P and 2.42% to 3.48% for K. Similar findings on moisture extraction from 30-60 cm. soil layers (40%) was also reported by Mohiuddin (1970). Singh and Bains (1971) reported that jowar (CSH-1) got high moisture use efficiency of 15 Kgs./mm. with a low seasonal Et. of 315 mm. with 3.0 mm./day water use. Srivastava (1971) reported that P content was 0.17% to 0.19% in jowar straw and 0.52% to 0.63% in jowar grain.

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~~jowar grain~~.

Bajra crop with its quick initial liniar growth recorded 42 cms. height by 30th day and 82 cms. on 80th day of crop age and had maximum widespread canopy at 30th day (Fig. 5). Dry matter production of this crop was slow (1.2 gms./day) during first 30 days and increased gradually between 30th to 60th day (3.3 gm./day) with a peak production thereafter (6.6 gms./day). Deeper root system enabled this crop to extract considerable proportion of water (38%) from 30-60 cm. layer and the rest was contributed by the upper layers. Grain yields (4616 Kgs./ha) and the monetary values (Rs.3474) for this crop were optimum. This crop recorded 358 mm. total Et. in 107 days with an average of 3.37 mm./day. All these factors collectively resulted in minimum Et.-ratio (1328 Kgs. water/Kg.produce or 1766 lit.water per rupee produce) and maximum water use efficiency (0.98q.grain per cm. or Rs.73/cm.) for this crop as compared to other crops. This crop recorded higher water use efficiency in 40% A.S.M.D. regime as compared to 60% A.S.M.D. regime. N, P and K content in this crop at harvest ranged from 2.10% to 2.95%, 1.12% to 1.37% and 2.80% to 3.29% respectively. Joshi (1969) reported that the moisture extraction pattern of bajra (HB-1) on sandy loam soils in summer was 38%, 31%, 18% and 13% from the successive 15 cm. soil layers respectively. Laxminarayana and Reddy (1969) reported that the daily Et. requirement for local bajra was 3.63 mm. Reddy (1971) reported that uptake of P by the bajra crop was 19.81 to 26.40 Kg./ha, when the yields of grain and straw were 16 to 17 q./ha. and 34 to 35 q./ha. respectively.

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He also reported that a final stage, N and K content in bajra plant ranged from 0.92% to 0.96% and 1.953% to 2.004% respectively.

Castor crop with its slow initial growth rate recorded 26 cms. height during first 40 days. Thereafter its height increased rapidly to 60 cms. by 64th day (Fig.4). Canopy of castor crop was also limited compared to its spacing. The monetary returns from this crop was Rs. 848/ha. as a result of 625 Kg./ha. yields. Deeper root system enabled it to tap more moisture (39%) from 30-60 cm. layer and rest was drawn from 0-30 cm. layer. Its total water requirement was about 381 mm. over a period of 126 days, with a daily requirement of 3.02 mm./day The Et.-ratio of castor bean production was high (5433 Kgs.water per Kg.of produce or 4012 lit. water/ruppee produce) and water use efficiency was low (0.23 q./cm. or 31 Rs./cm.) as compared to other crops. Percentage of N, P and K in castor plant at the time of harvest ranged from 3.78% to 4.36%, 0.58% to 0.79% and 0.90% to 1.17% respectively.

A gradual but slow rate of increase in plant height (Fig.4) and dry matter production was characteristic of the early stages of groundnut crop. A rapid increase in drymatter production was however, observed after 60th day till harvest (2.7 gms./day). Due to more root proliferation in 0-15 cm. layer about 39% soil moisture was drawn from this layer. With an average yield of about 1613 Kgs. of pods/ha. the monetary returns were Rs.1826/ha. with a total Et. of 362 mm. spread over a duration

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of 115 days, its daily Et. requirement being 3.14 mm./day. All these trends ultimately resulted in 0.44 q. of pods/cm. or 49 Rs./cm.(water use efficiency) and an Et.-ratio of 3097 Kgs. of water/Kg.pod or 2734 lit.water/rupee produce). N, P and K content in plant ranged from 4.26% to 5.87%, 0.52% to 0.68% and 0.41% to 0.56% respectively. Suraj Bhan and Misra (1970b) reported that water use efficiency of groundnut as 0.43 q./cm. and its total Et. requirement was 370 mm. Laxminarayana and Reddy (1969) reported that daily Et. requirement of groundnut crop as 3.18 mm. per day.

Korra crop height increased rapidly on an average with a constant rate of 1.1 cm./day resulting in 33 cms. height by 30th days and 78 cms. by 64 days of crop age. Dry matter production was low (0.69 gms./day) during first 30 days, with a gradual increase to 1.8 gms./day during the stage from 30-60 days and 2.7 gms./day during the period from 60th day to harvest. Though korra recorded an yield of 1279 Kgs./ha (due to the low market value of the produce its monetary returns were only Rs.875/ha.). Shallow root system of this crop enabled it to tap more moisture (44%) from 0-15 cm. layer and less from deeper layers. The total Et. requirement was also low (250 mm.) spread over a duration of 77 days and thus requiring 3.24 mm. Et./day. All these factors ultimately resulted in an Et.-ratio of 2049 Kgs.water/Kg. of produce or 2918 lt.water/rupee produce and a water use efficiency of 0.50 q.grain/cm. and 35 Rs./cm. At the time of harvest N, P and K content in korra plant samples

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ranged between 2.13% - 3.12%, 0.67% to 1.05% and 1.54% to 1.88% respectively. Laximinaryana and Reddy (1969) reported that korra daily Et. requirement as 3.20 mm.

Sesamum crop growth rate was slow in initial stages (20 cms. in 40 days) and rapid thereafter with an increase of 52 cms. between 40th and 80th day of crop (Fig.4). Dry matter production was also low during the first 30 days (1.28 gms./day) which increased gradually to 3.84 gms./day during 30-60 days and to 4.26 gms./day subsequent to this period. With an average yield of 706 Kgs.seed/ha. the monetary returns were about Rs.1699/ha. Sesamum tapped considerable moisture (39.5%) from surface layer (0-15 cm.) and with a total Et. of 337 mm. over 102 days, its daily requirement was 3.33 mm./day. The Et. ratio was 4640 Kgs. of water/Kg. seed or 1927 lit.water/rupee produce and a water use efficiency 0.23 q.seed/cm. or 50 Rs./cm. was also observed. At the time of harvest N, P and K content in plant samples ranged between 3.54% to 5.34%, 0.57% to 0.74% and 0.47% to 0.71% respectively.

Among pure crops, the water use efficiency (q. of produce/cm. of water applied) recorded in order of magnitude was bajra (0.98), korra (0.50), groundnut (0.44), jowar (0.43) sesamum and castor (0.23)q.cm). To produce one Kg. of economic produce the water requirements were 5432 Kgs. for castor, 4640 Kgs. for sesamum, 3795 Kgs. for jowar, 3097 Kgs. for groundnut, 2049 Kg. for korra and 1328 Kg. for bajra (tables 15 and 17)

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The pattern of growth of these crops showed that jowar, bajra and korra crops recorded rapid initial increase in plant height followed by castor and sesamum, while in groundnut the rate of height increase was comparatively very low (Fig.4). Similarly jowar crop registered very high rate of dry matter production (3.0 gms./day) in the early stages followed by that of bajra and sesamum (1.2 gms./day). Korra castor and groundnut had only 0.6 to 0.8 gms. per day production of dry matter in the earlier stages. However, rate of drymatter production after 30 days was high upto harvest stage in bajra crop, while in sesamum it was only upto 60 days crop age. Korra and castor recorded identical increase in drymatter upto 60 days (1.8 gms./day) and thereafter only korra continued its dry matter production. In groundnut dry matter production was at its peak (2.7 gm./day) during the stage from 60 days to harvest (pod formation stage) (Fig.6). These trends indicated that crop combination of jowar,-groundnut, bajra-groundnut, castor-groundnut had differences in dry matter production and also moisture extraction pattern to avoid mutual competition. (Even bajra and castor also differed to some extent in dry matter production). However, bajra-sesamum, bajra-korra, castor-korra and to some extent jowar-sesamum and jowar-korra competed mutually with higher rates of dry matter production (Fig.6 and Appendix VII). Based on these trends sesamum-groundnut, bajra-castor and also korra-groundnut combinations can be tried for their suitability of growing as mixed crops. However, the soil moisture extraction pattern did not differ in these combinations for mutual benefit. The crop canopy of castor

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was least interfering with companion crop while that of bajra dominated prominently.

The daily Et. requirements also showed considerable reduction in groundnut crop combination treatments (groundnut+bajra, groundnut+jowar, groundnut+castor). Similar trends were also recorded in korra + castor, sesamum + castor combinations. Reduction in daily Et. requirement in these two combinations appeared to be mainly due to shorter duration of korra (76 days) and sesamum (102 days) crops compared to castor (126 days). However, the reduction in daily Et. requirement in groundnut crop combinations could only be attributed to mini-shelter belt effects in minimising the consumptive use requirement. (Saraf & Dastane 1966, Skidmore and Hagen 1970b). The reduction in daily Et. requirement in groundnut + castor was further confirmed by the record of higher humidity in the treatment (Fig.16).

The trends in yield/unit area shown in table (11) indicated that in groundnut-castor and korra-castor combinations, yield levels of either or both the crops increased as compared to pure crops. In several combinations, the yield of the short statured crops (normally maincrop) decreased while that of the tall crops (normally intercrop) increased. This appeared to be partly due to better canopy development and light interception by the tall inter crops. In korra + castor combination, korra being taller than castor in earlier stages, recorded higher yields/unit area compared to korra pure crop. This trend was further confirmed by the observation on per unit row length yield nearer and away from the inter crop (Table 6)

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The trends in Et. ratio (lit.water/rupee produce (table 16) indicated that with groundnut crop combinations less water was required, to produce the yield worth a rupee, while in other two crop combinations this ratio increased with one or two exceptions. Similar favourable trends were also observed in water use efficiency (Rs./cm.) (Table 14).

Groundnut-bajra, groundnut-jowar, groundnut-korra had wide differences in N, P and K requirements to avoid mutual competition. Groundnut-sesamum, groundnut-castor, sesamum-castor had only marginal differences in nitrogen requirement. Korra-bajra, korra-jowar had wide differences in P and K requirements. These trends indicated groundnut-jowar, groundnut-bajra and to some extent groundnut-castor combinations were best suited in mixed cropping, as competition for nutrients in these combinations was least (Tables 24-29).

To sum up the discussion, groundnut-jowar, groundnut-bajra and groundnut-castor showed differences in dry matter production trends, moisture extraction pattern and also in nutritional requirements. This resulted in avoidance of mutual competition. Reduction in Et. requirements in groundnut crop combinations could be attributed to minishelter effects in minimising Et. Reduction in Et. requirements in korra + castor and sesamum + castor combinations were due to shorter duration of korra and sesamum crops as compared to castor crop. In several combinations, the yield of short statured crops (normally main crops)

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decreased while that of tall crops (normally inter crops) increased on per unit area basis. This appeared to be partly due to canopy development and light interception by tall crops. Et. ratio of groundnut combinations were lower, whereas water use efficiencies were higher as compared to other combinations.

SUMMARY AND CONCLUSIONS

C H A P T E R - 6

SUMMARY AND CONCLUSIONS

An experiment ("Studies on the mixed cropping compatability of six crops, grown under two soil moisture regimes") was conducted at the college farm of college of agriculture, Rajendranagar on sandy loam soil during summer, 1972, to evaluate six crops for their compatability in mixed cropping under two soil moisture regimes. For this study three relatively short statured crops viz., groundnut, sesamum and korra were grown as main crops and three relatively taller crops viz., jowar, bajra and castor were grown as inter crops in 4 : 1 ratio. The experiment was laid out in split-plot design with 15 main treatments (6 pure crops treatments + 3 x 3 = 9 mixed crop treatments). Two soil moisture regimes 40% and 60% A.S.M.D. were adopted as sub-plot treatments. These treatments were replicated three times.

The salient features of experimental findings are summarized below:

1. Bajra crop recorded maximum height and higher rate of dry matter production/day as compared to other crops viz., jowar, castor, groundnut, sesamum and castor. Groundnut-jowar, groundnut-bajra and groundnut-castor had differences in dry matter production trends, to avoid mutual competition. Bajra-sesamum, bajra-korra and Castor-korra competed mutually with higher rates of dry matter production. The canopy of castor crop was least interfering with companion crop, while that of bajra dominated prominently.

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2. Bajra as a pure crop treatment recorded higher monetary returns (Rs.3474) while castor pure crop treatment recorded lowest monetary returns (Rs.848) when compared to other crops. In groundnut-castor, and korra-castor combinations yield levels of either or both the crops increased than pure individual crops. Jowar, bajra and castor recorded higher yields, when grown as inter crops than grown as pure crops on per unit area basis.

3. The daily requirement of Et. was higher in bajra crop (3.37mm) as compared to castor (3.02 mm) which was also minimum in pure crop treatment. Total Et. requirement of castor (381 mm.) was higher as compared to lower Et. requirement of korra (250 mm.). All the three groundnut crop combinations recorded lower Et./day as compared to pure groundnut crop treatment. Korra + castor and Sesamum + castor combinations also recorded lower Et./day as compared to pure korra and pure sesamum crops respectively. Jowar, bajra and castor tapped more moisture from 30-60 cm. layers while korra, groundnut and sesamum extracted more moisture from 0-15 cm. surface layer.

Bajra crop recorded higher water use efficiency Rs.73/cm) followed by sesamum (Rs.55/cm.), groundnut (Rs.49/cm.), Korra (Rs.35/cm.) jowar (Rs.33/cm.) and castor (Rs.31/cm). Jowar crop recorded higher Et. ratio (4881 lit./Re.) followed by castor (4012 lit./Re.), korra (2918 lit/Re.), groundnut (2734 lit./Re.), sesamum (1927 lit./Re.) and

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bajra (1766 lit./Re.). Among mixed crop treatments, groundnut crop combinations recorded higher water use efficiency (Rs.43-53 per cm.) and lower Et.-ratios (1948 - 2444 lit./Re.) compared to other crop combinations.

4. Mostly groundnut-jowar, groundnut-bajra and to some extent groundnut-castor had differences in their nutritional requirements, to avoid mutual competition.

The trends in this experiment had indicated certain guidelines for further work such as : sesamum-groundnut, bajra-castor and korra-groundnut combinations can be tried for their suitability of growing as mixed crops. Different row spacings and also number of rows for main crop can be tried so that the zone of influence of shelter belt can be understood. Mini-shelter-belt (taller intercrop) effect on main crop needs to be assessed in relation to height and permeability of shelter belt, wind velocity and direction to understand the extent of influence of shelter belt. Such observations are desirable both under irrigated and dry land farming to improve the water use efficiency of crops.

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APPENDICES

APPENDIX I

METEOROLOGICAL DATA

Fortnightly periods	Temperature		Humidity %		Sunshine hours/day	Evaporation per day (in mm)	Total Rainfall (in mm)
	Max.°C	Min.°C	7-00 hr.	14-00 hr.			
January I half	28.9	9.6	87	37	10.4	4.53	--
January II half	27.9	12.4	88	33	10.1	5.31	--
February I half	30.8	15.4	70	34	10.2	6.00	--
February II half	31.3	15.5	77	37	9.9	7.25	50.0
March I half	34.8	17.7	62	21	10.2	8.06	--
March II half	37.4	20.4	61	15	10.2	9.11	--
April I half	37.2	23.1	64	25	9.8	8.07	13.6
April II half	38.0	25.2	54	21	9.2	9.94	1.0
May I half	37.6	24.6	60	28	8.4	9.93	18.1
May II half	39.5	26.8	56	21	9.4	13.4	--
June I half	40.4	26.8	50	21	8.2	12.7	0.2
June II half	32.9	23.6	82	56	4.5	6.7	111.5

GRAIN YIELDS /NET PLOT (TREATMENT-WISE AND REPLICATION-WISE
(Kgs./15.75 m^2)

Treatments	40% A.S.M.D.						60% A.S.M.D.					
	R_1		R_2		R_3		R_1		R_2		R_3	
	A	B	A	B	A	B	A	B	A	B	A	B
Jowar	-	4.96	-	3.45	-	0.72	--	2.39	--	3.12	--	1.73
Bajra	-	9.67	-	10.65	-	3.00	--	7.15	--	10.55	--	2.51
Castor	-	2.14	-	.15	-	0.72	--	1.56	--	0.42	--	0.92
Groundnut	3.7	--	3.3	--	1.0	--	2.75	--	2.3	--	2.2	--
Korra	1.7	--	2.1	--	2.3	--	2.20	--	2.0	--	1.85	--
Sesamum	1.76	--	0.89	--	0.91	--	1.17	--	0.92	--	1.01	--
Groundnut+ jowar	1.65	1.5	1.75	2.27	1.0	0.72	1.2	1.55	0.9	1.77	0.9	1.73
Groundnut+ Bajra	2.15	4.2	1.9	1.85	1.2	0.51	0.4	2.85	2.1	1.50	1.1	0.3
G.nut+Castor	1.5	1.12	2.2	0.59	2.67	0.33	1.85	0.86	1.8	0.52	1.5	0.3
Korra+Jowar	2.14	1.1	1.12	1.54	0.25	0.59	1.60	0.32	1.0	0.71	0.6	1.42
Korra+Bajra	1.3	1.9	1.6	1.25	1.2	1.5	1.15	1.6	1.35	0.99	1.4	1.45
Korra+Castor	2.08	0.28	3.3	0.19	1.2	0.18	3.05	0.75	1.65	0.13	1.0	0.24
Sesamum+Jowar	1.07	1.16	1.1	1.9	0.38	0.15	1.1	0.7	0.32	2.1	0.23	0.24
Sesamum+Bajra	0.96	2.1	0.19	1.8	0.45	0.35	0.31	2.15	0.74	0.61	0.54	0.75
Sesamum+Castor	1.07	0.11	1.06	0.38	1.10	0.10	0.76	0.10	0.71	0.10	0.67	0.06

A = Main crop (entire)
B = Subsidiary crop

In mixed crop treatments area occupied by main crop = 80% of 15.75 m^2 (but in sesamum combinations it is 85%.).

APPENDIX III

SAMPLE A.V. TABLE FOR MONETARY RETURNS

Source of Variation	Degrees of freedom	SS	MSS	F-Value	Test of signi-ficance	S.E.	C.D.
Replication	2	12724394					
Main Treatments	14	34258388	2447028	4.00	Highly signifi-cant.	451.4	924.47
Pure Vs. intercrops	1	692379	692379	1.13	not signi-ficant	451.4	--
Within pure crops	5	28145371	5629074	9.21	highly signifi-cant	451.4	924.47
Within intercrops	8	5420638	677580	1.11	Not signi-ficant	451.4	--
Error (a)	28	17115892	611282				
Sub-treatment	1	1738976	1738976	8.60	highly si-gnificant	94.8	193.58
Interaction	14	1030323	73595		Not signi-ficant	367.1	--
Error (b)	30	6067348	202245				
Total ...	89	72935321					

APPENDIX IV

SAMPLES A.V. TABLE FOR MAIN CROP CHARACTERS

(Korra Plant height (cms.)

Source of Variation	Degrees of freedom.	SS	MSS	F-Value	Test of significance	S.E.	C.D.
Replication	2	1197					
Crop treatments	6	2628	438	2.84	Significant	7.15	14.700
Regimes	1	772	772	5.01	Significant	3.9	8.018
Crop treatment x regimes	6	358	59.6		Not significant	10.14	--
Error	26	4006	154				
Total ..	43	8961					

APPENDIX V

SAMPLE A.V. TABLE FOR INTER CROP (SUBSIDIARY CROP)

(Percent of Castor seed to pods by Weight)

Source of Variation	Degrees of freedom	SS	MSS	F-Value	Test of significance	S.E.	C.D.
Replication	2	401.67					
Crop treatments	3	1655.75	551.91	5.64	significant	5.7	12.23
Regimes	1	1356.01	1356.01	13.87	significant	3.05	6.54
Crop treatment x regimes	3	955.39	318.46	3.25	Not significant.	8.08	--
Error	14	1368.46	97.74				
Total ..	23	5737.28					

APPENDIX VI

PERIODICAL PLANT HEIGHT (Cms.)

Sl No	Crop with treatment	Age in days after sowing											
		30		43		64		82		104		Before Harvest	
		40% ASMD	60% ASMD	40% ASMD	60% ASMD	40% ASMD	60% ASMD	40% ASMD	60% ASMD	40% ASMD	60% ASMD	40% ASMD	60% ASMD
1	2	3	4	5	6	7	8	9	10	11	12	13	14
1.	Jowar (J)	42.0	36.0	36.0	60.0	80.5	74.4	84.2	79.1	89.5	82.4	93.4	95.2
2.	Groundnut(G)	5.0	5.0	10.0	10.0	15.5	15.0	21.5	20.5	24.5	24.5	25.6	24.6
3.	Bajra (B)	42.0	38.0	64.0	54.6	76.4	70.4	82.1	83.1	--	--	101.1	97.4
4.	Korra (K)	33.0	33.0	44.0	42.0	78.6	66.0	--	--	--	--	80.6	69.0
5.	Sesamum(S)	17.0	16.0	20.0	20.0	64.0	48.0	72.3	63.0	--	--	78.3	77.7
6.	Castor (C)	15.0	12.0	26.0	22.0	60.0	48.0	72.0	59.0	78.2	62.0	81.2	67.6
7.	C + J J	40.0	41.0	50.0	46.0	82.3	72.6	88.0	78.0	92.0	90.0	96.9	92.2
	G_1	6.0	5.0	10.0	10.0	18.0	19.0	22.0	21.0	26.0	24.0	30.1	26.2
	G_2	4.0	4.5	7.0	6.0	19.0	18.0	21.7	19.0	27.0	24.0	25.6	24.9
8.	G + B B	45.0	41.0	57.0	47.0	72.4	68.6	78.0	70.4	--	--	85.3	90.6
	G_1	7.0	8.0	9.0	9.0	18.1	18.1	19.4	19.0	23.0	19.4	26.5	25.4
	G_2	7.0	7.0	9.5	10.0	14.0	12.0	15.0	17.0	18.0	19.2	25.5	25.3
9.	G + C C	18.0	13.0	22.0	21.0	61.0	56.0	63.0	60.0	67.0	63.0	73.1	65.6
	G_1	6.0	10.5	11.0	12.0	18.0	15.0	19.8	19.1	25.3	24.2	27.3	28.3
	G_2	5.0	11.0	9.0	13.0	18.5	16.0	20.1	18.8	24.6	25.6	25.6	29.4
10.	K + J J	47.0	39.0	60.0	48.0	79.1	71.1	84.9	84.2	88.0	85.0	92.1	87.3
	K_1	44.0	36.0	48.0	39.0	64.6	64.0	--	--	--	--	70.6	55.6
	K_2	38.0	23.0	48.0	36.0	60.6	50.0	--	--	--	--	64.6	52.3

Contd...p.129

1	2	3	4	5	6	7	8	9	10	11	12	13	14
11 K + B	B	42.0	40.0	59.0	52.0	70.4	66.4	78.1	71.1	--	--	86.0	84.3
	K_1	37.0	30.0	48.0	48.0	63.4	64.0	--	--	--	--	78.0	68.3
	K_2	36.0	30.0	40.0	42.0	62.1	65.0	--	--	--	--	77.6	70.6
12 K + C	C	16.0	17.0	19.0	25.0	65.0	50.0	69.0	64.0	70.1	70.0	70.6	76.8
	K_1	33.0	31.0	46.0	49.0	61.4	64.0	--	--	--	--	86.0	78.3
	K_2	36.0	34.0	52.4	48.0	65.6	59.0	--	--	--	--	77.6	82.0
13 S + J	J	32.0	29.0	51.0	46.0	70.1	71.0	79.1	79.0	82.9	83.0	91.1	96.2
	S_1	13.0	15.0	21.0	24.0	61.0	60.0	62.5	65.0	--	--	74.3	72.3
	S_2	14.0	14.0	18.0	22.0	71.8	64.0	73.1	67.0	--	--	98.3	88.0
14 S + B	B	54.0	51.0	65.0	62.0	87.4	70.2	98.3	71.5	--	--	103.3	74.9
	S_1	10.5	8.0	15.0	15.0	63.2	53.0	69.5	60.4	--	--	82.7	67.3
	S_2	11.5	8.0	14.0	10.0	57.8	47.0	62.5	56.1	--	--	73.6	59.7
15 S + C	C	13.0	11.0	26.0	16.0	62.0	52.0	64.3	59.0	65.4	68.4	73.0	75.6
	S_1	10.0	6.0	27.0	17.0	56.0	59.0	63.5	67.1	--	--	74.7	74.0
	S_2	13.0	7.0	23.0	15.0	63.0	60.0	68.7	69.3	--	--	83.3	76.3

- Indicates crop reached harvest stage or already harvested
1 Corresponds to main crop ht. adjacent to inter crop row
2 Corresponds to main crop ht. away to inter crop row

DRY MATTER PRODUCTION GMS./½ m^2 AREA

Treatment	40% A.S.M.D. REGIME						60% A.S.M.D. REGIME					
	Cumulative			Rate			Cumulative			Rate		
	at 30 days	at 60 days	at harvest	0-30 days	30-60 days	60 to harvest	at 30 days	at 60 days	at harvest	0-30 days	30-60 days	60 to harvest
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
Jowar (J)	90.0	174.0	284.4	3.0	2.8	2.16	72	150	240.6	2.4	2.6	1.78
Groundnut(G)	24.0	49.2	192.0	0.80	0.84	2.70	22.8	49.2	156.0	0.76	0.91	2.01
Bajra (B)	36.0	132.0	417.6	1.2	3.27	6.64	34.8	139.2	382.8	1.16	3.48	5.66
Korra (K)	20.6	74.4	112.0	0.69	1.79	2.70	18.0	54.2	82.0	0.60	1.21	1.99
Sesamum (S)	38.4	153.6	315.6	1.28	3.84	4.26	40.8	114.0	296.4	1.36	3.44	4.01
Castor (C)	16.8	72.0	192.0	0.56	1.84	1.87	17.2	80.0	168.0	0.64	2.09	1.84
G + J J	91.8	198.4	384.6	3.06	3.55	3.65	92.4	223.2	393.6	3.08	4.36	3.34
G*	24.0	48.0	135.0	0.80	0.80	1.65	21.6	46.8	111.6	0.72	0.84	1.22
G**	31.2	50.4	180.0	1.04	0.64	2.44	31.8	50.4	135.6	1.06	0.62	1.61
G + B B	31.8	127.8	409.2	1.06	3.20	6.54	33.6	118.6	359.4	1.12	2.84	5.60
G*	25.2	50.4	156.0	0.84	0.84	2.00	24.0	49.2	162.0	0.80	0.84	2.13
G**	26.4	49.2	164.4	0.88	0.76	2.17	26.4	46.8	152.4	0.88	0.68	2.00
G+C C	12.8	96.4	224.0	0.43	2.79	2.00	12.8	92.4	200.0	0.43	2.65	1.68
G*	26.4	48.0	159.6	0.88	0.72	2.10	27.6	45.6	144.0	0.92	0.60	1.85
G**	30.0	52.8	157.2	1.00	0.76	1.97	32.8	54.0	188.4	1.09	0.71	2.53
K + J J	78.0	196.0	384.6	2.60	3.93	3.70	84.0	144.0	240.6	2.8	2.0	1.90
K*	17.6	55.2	72.0	0.59	1.25	1.34	18.2	46.2	52.0	0.61	0.93	0.41
K**	17.0	40.8	56.0	0.57	0.79	1.10	18.6	54.8	58.0	0.62	1.21	0.23

Contd.. on p.131

APPENDIX VII Contd...

1		2	3	4	5	6	7	8	9	10	11	12	13
K + B	B	36.6	168.6	417.0	1.22	4.40	5.77	35.4	174.6	400.8	1.18	4.64	5.60
	K*	17.2	65.0	100.0	0.57	1.59	2.50	20.8	71.6	100.0	0.69	1.69	2.03
	K**	16.8	55.2	98.0	0.56	1.28	3.06	19.6	60.8	68.0	0.65	1.37	0.51
K + C	C	18.8	76.4	188.0	0.63	1.92	1.74	17.2	75.2	192.0	0.57	1.93	1.82
	K*	19.8	70.4	102.0	0.66	1.65	2.13	21.4	64.0	94.0	0.71	1.42	2.14
	K**	19.6	59.2	84.0	0.65	1.32	1.77	21.2	66.2	76.0	0.71	1.50	0.70
S + J	J	90.0	222.6	354.6	3.0	4.42	2.60	83.4	207.0	288.0	2.78	4.12	1.60
	S*	39.6	163.2	339.6	1.32	4.12	4.64	34.8	127.2	222.0	1.16	3.08	2.50
	S**	38.4	193.2	322.8	1.28	5.16	3.41	37.2	169.2	229.2	1.24	4.40	1.60
S + B	B	30.6	124.8	481.4	1.02	3.14	7.14	30.0	120.0	399.0	1.00	3.00	6.48
	S*	37.8	177.6	259.2	1.26	4.66	2.14	38.4	181.2	242.4	1.28	4.76	1.61
	S**	46.8	177.6	279.6	1.56	4.36	2.70	45.6	174.0	253.2	1.52	4.28	2.08
S + C	C	15.6	60.6	136.0	0.52	1.48	1.18	16.0	60.8	148.0	0.53	1.49	1.36
	S*	34.8	141.2	253.2	1.16	3.55	2.91	36.0	180.0	241.2	1.20	4.80	1.61
	S**	39.6	169.2	256.8	1.32	4.32	2.30	38.0	180.0	267.6	1.27	4.73	2.30

* = Main crop adjacent to intercrop row

** = Main crop away from intercrop row.

APPENDIX VIII

MOISTURE DEPLETION PERCENTAGES FROM DIFFERENT SOIL REGIMES BEFORE EACH IRRIGATION

Treatment	Depth in cm.	40% A.S.M.D. regime depletion on							60% A.S.M.D. regime depletion on					Dates
		3/3	15/3	25/3	5/4	15/4	25/4	7/5	7/3	23/3	8/4	24/4	8/5	
1.	2.	3	4	5	6	7	8	9	10	11	12	13	14	
Jowar	0-15	52	46	52	56	44	51	45	73	62	65	72	63	
	15-30	29	23	28	33	25	30	37	50	48	42	48	53	
	30-60	17	24	18	37	16	32	31	26	48	21	38	50	
Groundnut	0-15	42	40	53	52	46	42	41	68	69	66	71	73	
	15-30	36	28	23	39	25	35	30	52	39	15	43	60	
	30-60	22	16	27	22	20	37	23	28	21	33	39	20	
Bajra	0-15	55	48	50	52	47	48	47	77	69	70	77	75	
	15-30	33	33	38	41	34	33	31	46	41	56	60	61	
	30-60	35	27	25	29	27	34	26	34	28	37	40	50	
Korra	0-15	48	48	55	50	50	66	--	77	70	79	74	--	
	15-30	31	34	31	30	34	38	--	51	51	47	41	--	
	30-60	17	17	25	23	22	20	--	20	22	21	20	--	
Sesamum	0-15	48	63	45	47	53	51	48	73	64	59	68	71	
	15-30	29	37	28	18	35	30	43	46	55	56	43	53	
	30-60	28	21	16	28	27	29	29	21	18	27	24	21	
Castor	0-15	52	47	48	51	51	40	46	71	65	70	76	73	
	15-30	24	26	37	28	38	31	38	44	40	55	43	59	
	30-60	20	25	31	33	29	29	19	19	30	38	37	43	
G + J	0-15	51	37	57	41	51	47	50	48	65	67	71	71	
	15-30	35	31	31	28	34	37	39	49	50	49	48	54	
	30-60	21	22	25	19	27	20	26	22	28	28	26	51	

Contd...133

APPENDIX VIII Contd...

1	2	3	4	5	6	7	8	9	10	11	12	13	14
G + B	0-15	45	45	48	53	51	51	47	72	68	69	69	71
	15-30	36	28	32	32	39	30	35	49	55	48	52	59
	30-60	20	18	20	22	28	21	24	29	27	28	23	34
G + C	0-15	50	45	39	48	48	44	39	68	68	68	67	78
	15-30	29	26	36	33	40	41	39	43	36	51	47	49
	30-60	23	21	26	19	25	29	23	18	27	30	36	38
K + J	0-15	49	54	42	49	50	57	42	76	64	71	75	72
	15-30	29	37	35	34	35	31	39	60	49	58	48	60
	30-60	22	21	28	27	25	19	22	20	23	29	25	40
K + B	0-15	45	51	50	50	52	47	42	72	67	73	67	74
	15-30	30	29	35	51	34	30	36	52	49	53	51	51
	30-60	20	21	26	16	24	26	18	31	28	32	26	44
K + C	0-15	50	55	51	51	53	51	46	73	69	66	67	81
	15-30	33	28	39	32	36	38	36	46	46	53	46	48
	30-60	17	21	21	28	18	19	23	20	36	28	43	44
S + J	0-15	42	51	48	52	45	48	47	70	65	65	73	77
	15-30	27	34	32	35	36	37	36	50	53	49	48	63
	30-60	25	29	23	24	19	23	21	28	22	24	38	38
S + B	0-15	52	55	47	52	47	57	50	74	69	69	71	77
	15-30	31	31	38	28	33	30	36	51	52	43	57	58
	30-60	21	24	21	20	21	22	20	28	34	83	34	45
S + C	0-15	46	47	49	48	50	53	53	69	65	67	67	71
	15-30	27	29	29	22	35	30	30	45	44	44	52	62
	30-60	15	23	29	23	20	19	24	26	37	23	32	38