Effects of Irrigation Levels and Mulches on Growth and Yield of Jowar (Sorghum bicolor [L.] Moench) Varieties Under Summer Conditions

By

Bajaram Kondiba Kadam

B. Sc. (Agri.) Hons.

A Thesis submitted to the

MAHATMA PHULE KRISHI VIDYAPEETH

(AGRICULTURAL UNIVERSITY)

RAHURI, District AHMEDNAGAR.

(MAHARASHTRA STATE)

in partial fulfilment of the requirements for the Degree of

Master of Science (Agriculture)

in

AGRONOMY

DEPARTMENT OF AGRONOMY

Post-Graduate School, Rahuri

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JANUARY, 1979

Approved by the Advisory Committee :

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CERTIFICATE

I, hereby certify that the thesis entitled "Effects of irrigation levels and mulches on growth and yield of Jowar (*Sorghum bicolor* [L.] Moench) varieties under summer conditions", submitted to the Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar in partial fulfilment of the requirements for the degree of MASTER OF SCIENCE (AGRICULTURE) in AGRONOMY is a record of *bona fide* research carried out by Shri B.K. Kadam, under my guidance and supervision. It is of a sufficiently high standard to warrant its submission to the Vidyapeeth (University) for the award of the said degree. No part of the thesis has been submitted anywhere for publication or for any other degree of any University.

The assistance and help received during the course of this investigation and sources of literature referred to have been duly acknowledged.

Rahuri,

Dated :

(S.T. Kenjale)
Research Guide.

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Dated : January, 1979.

CONTENTS

LIST OF ILLUSTRATIONS

List of abbreviations used in the thesis

mm	-	Millimetre
cm	-	Centimetre
dm^2	-	Decimetre square
g	-	Gramme
kg	-	Kilogramme
q	-	Quintal/s
t	-	Tonne
ha	-	Hectare
^oC	-	Degrees centigrade.
S.E.	-	Standard Error.
C.D.	-	Critical Difference.

Chapter I

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

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Chapter I

INTRODUCTION

Jowar (Sorghum bicolor, [L.] Moench) is one of the important food grain crops grown in India. It is extensively grown in Central and Southern States of the Country. In India, in acreage, it ranks next only to rice and in production, it stands third after rice and wheat. Maharashtra ranks first in acreage and production in the country. However, the average yields in Maharashtra are very low i.e. 9.9 q and 5.9 q per hectare during kharif and rabi seasons respectively.

Per hectare yield of jowar is very low mainly because the crop is largely grown under rainfed conditions in both kharif and rabi seasons with limited fertilizer use and under inadequate moisture conditions. To achieve self sufficiency of food grains and to feed up the vast and increasing population of the country, systematic efforts to increase per unit and thereby total production of jowar is a hard pressing need of the country.

With the introduction of hybrids and high yielding varieties of jowar, the crop received lot of impetus and several agronomic experiments have been conducted in the main sorghum growing regions of Maharashtra, to find out suitable agronomic practices under varied conditions of soil and climate. Experimental evidences indicated that jowar can be grown successfully under summer conditions in this region. Thus, one of the ways of increasing the food grain production in Maharashtra State is to grow jowar during summer season.

Possibility of growing jowar during summer, in Maharashtra, opens up an avenue of research opportunities to the research workers to work out different agronomic practices. It is very important, therefore, to exploit the potentials of different hybrids and high yielding varieties during summer by making judicious use of available resources like irrigation water and fertilizers and taking up appropriate plant protection measures.

For maximization of yields and for the economic grain production of sorghum under irrigated tracts, it is necessary to increase the soil moisture use efficiency. For this, the assessment of optimum water needs of the crop by finding out the consumptive use of water is of a paramount importance.

There are number of factors which influence the amount of water consumed by plants such as soil conditions, plant type, weather conditions etc. According to Taylor (1965), "Irrigation should take place while the soil water potential is still high enough that the soil can and does supply water fast enough to meet the local atmospheric demands without placing the plants under a stress that would reduce the yield or quality of the harvested crops ". Penman (1948)

constituted a land mark of assessing water needs of the crops on the basis of meteorological parameters i.e. mainly surface pan evaporation. However, the irrigation agronomists should find out relationship between water use by crops and climatic data.

There are number of ways to increase the water use efficiency such as use of mulches, use of antitranspirants, defoliation etc. The use of mulch for moisture conservation has been practiced in high valued crops since long (MaCalla Army, 1961). Many of the workers indicated that mulches conserve considerable amount of moisture (Schaller and Evans, 1954; Willis et al., 1957; Moody et al., 1963; and Bond et al., 1970).

Organic materials, mainly agricultural wastes such as rice straw, wheat straw and bhoosa, grasses, stubbles, stovers, cotton stalks, tur stalks, sugarcane trash etc. were tried as a surface mulch by several research workers. In the irrigated tracts and where sugarcane is a main cash crop, an ample quantity of sugarcane trash is available. Most of the cultivators are burning the sugarcane trash in the field itself after harvesting and only few are using for preparation of organic manures. If this material is used as surface mulch, it will help in conserving soil moisture, lowering the day soil temperature and it may also help in reducing the weed intensity by supressing the weed growth. Moreover, considerable portion of the mulch material would remain in the soil and would thus add to the soil fertility.

In India, practically no work is done on the liquid mulches. In irrigated conditions, petrolium emulsion, a liquid mulch, gave high yields over straw mulches (Kolandaiswamy et al., 1967) in Tamil Nadu. The bitumen, which is used for roads, is available with low costs as compared to other liquid mulches and though it is tried as mulch in foreign countries is not so far tried in India. However, in India, bitumen is mainly used for the surface barriers to check the percolation losses in rice (Rao et al., 1972).

Thus irrigation water, a scares and costly commodity and more so under summer conditions, needs to be used with the scientific knowledge to increase its use efficiency by different crops under varied conditions of climate and soil. Further, though the practices like mulches, antitranspirants etc. have been advocated since long for increasing water use efficiency, no work on irrigation levels and mulches in jowar under summer conditions is so far done in this region.

With the above considerations in view, the present project to study the effects of irrigations (0.50 WUF* and 0.75 WUF) and three mulch treatments namely sugarcane trash, bitumen and control on growth and yield, under summer conditions was conducted in the instructional farm of the Central Campus, Mahatma Phule Krishi Vidyapeeth, Rahuri during summer 1977 with the following objectives.

1. To study the comparative growth and yield performance of a hybrid and a high yielding variety of jowar under summer conditions.

* is used for IW/CPE ratio

2. To study the suitability of surface mulches for boosting-up the *jowar* yields, during summer.

3. To study the relative efficacy of different mulches on the consumptive use of water by *jowar* under summer conditions.

Chapter II

REVIEW OF LITERATURE

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Chapter II

REVIEW OF LITERATURE

Sorghum is one of the several indispensible crops required as feed, food and industrial raw material. With the introduction of hybrid and high yielding varieties, which are responsive to good irrigation practices and judicious fertilization, sorghum production have been considerably improved in recent years. Extensive work has been done in recent years to work out different packages of practices for both *kharif* and *rabi jowar*. However, relatively little work appears to have been done and reported on response of these hybrids and high yielding varieties to irrigation levels and mulch treatments specially under summer conditions.

In this chapter, an attempt has been made to present a brief review of the work carried out on the above lines in *jowar* in particular and other cereals in general under appropriate heading as follows :

I. Effect of irrigations on growth and yield :

Painter and Leamer (1953) from the field investigations carried out on fine sandy loam soils on grain sorghum reported that the more frequent irrigations gave an average yield increase of 338.68 kg/ha over the drier regime.

Mathers *et al*. (1960) from field studies on water management and fertilizer with grain sorghum on silty clay loam in Texas, reported that the yield increases with irrigations when weighted mean tension in depletion zone was approximately

9 atmosphere and irrigations when irrigated mean tension in depletion zone was approximately 1.5 atmosphere were the only increases that were significant over preplanting irrigation treatment. The higher moisture level produced greater yields and utilised more of the available nitrogen.

Dastane et al. (1970) while reviewing the work done on water requirements of crops, in India, reported the results of irrigation experiments on sorghum hybrid CSH-1 conducted by Patil et al.at Siruguppa during kharif as well as during summer of 1968 and 1969. During kharif, irrigation at 25 per cent availability of soil moisture seemed to be adequate. During summer, in both the years, it was observed that irrigation at 50 per cent availability in the top 30 cm layer gave the highest yield. It involved 550 to 575 mm water in 9 to 10 irrigations.

Kramer and Ross (1970) commented that the most effective use of water was obtained when the sorghum crop was provided with adequate water for continuous vigorous growth throughout the season. When the crop was in severe moisture stress, that is when the available moisture in the top 60 cm of soil, was reduced below 25 per cent of total available storage capacity, potential yields were reduced.

Meli et al. (1970) working on sorghum hybrid, CSH-1 at Dharwar obtained greatest leaf area by maintaining continuous soil moisture regime of 100 to 50 per cent available moisture throughout the three plant stages viz. seedling, grand growth and maturity. The yield increases with 100 to

50 per cent available moisture regime treatment were 51 and 86 per cent over 100 to 75 per cent and 100 to 25 per cent available soil moisture regime respectively. The highest yield of 6892 kg/ha was obtained with 100 to 50 per cent moisture regime. Similar results were reported by Griffin _et al_. (1966).

Singh and Bains (1971) estimated at Indian Agricultural Research Institute, New Delhi, that the seasonal consumptive use of water by sorghum hybrid, CSH-1 and variety Swarna was 315 mm and 338 mm respectively during _kharif_ season. Water use efficiency values for CSH-1 and Swarna were 15 kg and 11 kg per mm, respectively.

Jadhav (1974) studied the effects of soil moisture regimes, that is irrigations at 20 per cent, 40 per cent and 60 per cent available soil moisture at Agricultural College Farm, Poona. The per hectare grain yield showed increase from 34 and 47 quintals with unirrigated treatment to about 69 and 78 quintals with irrigation at 40 per cent available soil moisture during _rabi_ 1971-72 and 1972-73 seasons respectively. Irrigating _jowar_ crop at about 58 to 60 per cent available soil moisture did not show any favourable influence on grain yield as compared to irrigating at 40 per cent available soil moisture. Fodder production showed progressive increase with the increase in the moisture regime. The per hectare fodder yield, with one irrigation at germination was 54 quintals, which increased to about 90 quintals with irrigations at 60 per cent availabae soil moisture.

Kaliappa et al. (1975) indicated that the maximum grain yield of sorghum, under Bhavanisagar conditions, was obtained with irrigations at 50 per cent moisture availability and with 100 kg N/ha.

II. Effect of mulches on growth and yield :

The practice of surface mulching affects favourably on development of roots, shoots, early emergence of reproductive parts and the yields, as more moisture and nutrients are made available for plant growth by way of effective uptake of nutrients where water is limiting factor.

Moody et al. (1968) studied the influence of straw mulch on corn growth and found that there was significant increase in growth of mulched over unmulched corn. Mulched corn was 64 cm taller at tasseling and produced 42 bushels per acre more grain.

Choudhary and Chattarjee (1967) observed that the heights of plant fractions recorded during the growth of the wheat crop, there was more root development under mulches than in no mulch treatments. They further observed that the effect of mulches on grain and straw yields were highly significant than without mulches. Wheat, barley, gram and linseed yielded 25, 28, 30 and 36 per cent more yield under mulch treatments, than no mulch treatment.

Kolandaiswamy et al. (1967) observed that straw mulch significantly improved straw yields of rainfed sorghum whereas petrolium emulsion gave the highest grain and straw yields from the irrigated crops. Pal and Pandey (1969) also observed increase in the fodder yields of jowar, bajra and maize consistantly due to straw mulch application. Greb et al. (1970) also observed similar results of straw mulch in wheat crop.

Greb et al. (1970) observed that the surface mulches (stubble) increased the yields of wheat at Sidney and correlated the same with increased water storage under mulch obtained during the preceeding fallow season.

Tiwari et al. (1970) studied the effect of surface mulch on the yield of wheat and found that mulching increased the grain yield significantly i.e. by 28 per cent over no mulch soil./ Saw dust increased the grain yield by 39 per cent over control followed by grass (27 per cent)and rice straw (17 per cent). A similar increase in the yield of maize by the use of wheat straw was observed by Borst and Mederski (1957) .

Bansal et al. (1971) studied the effect of mulches on growth of maize and pearl millet and found that the dry weight per plant at thinning was higher and plants were significantly taller under treatment of straw, cultivation and cultivation + straw than in the control. The final height of plants in straw mulch was greater than in all other treatments. It also gave highest increase of 155 kg maize grain per hectare or 35 per cent more yield than the yield obtained in the control.

Myhre and Sanford (1972) observed that straw mulch was more effective in increasing corn production. The weight of grain per ear was higher. An addition of 1631, 251 and 1192 kg/ha was obtained due to mulching in three successive years. Ali and Prasad (1972) also reported that grain yield of barley increased with the wheat straw mulch application at the rate of 4 t/ha.

At Dry Farming Centre, Solapur various organic and inorganic mulches were studied. Black polythyelene gave the highest yield of <u>rabi jowar</u> followed by red gram stalks and dry grass over no mulch treatment (Anonymous, 1972-a). Mulching with application of dry grass at the rate of 5 t/ha has shown an increase by about 41 per cent over unmulched conditions (Anonymous, 1972-b).

Kullmann <u>et al</u>. (1973) studied the effect of liquid mulching with bitumen emulsion on sugarbeat and grain maize, in German. It was observed that bitumen mulching in sugarbeet and grain maize improved seedling growth but yield increase obtained were insufficient to cover the cost of treatment.

Schmidt (1973) conducted a field trial, at Berline, with light sandy soil. Bitumen emulsion was applied in bands of 15 cm wide (1800 litres/ha), 25 cm wide (3000 litres/ha) or over the whole area at 6000 litres/ha to the plots of silage maize and sugarbeet. As band width increased, soil temperature, at sowing depth, increased, emergence and growth were promoted, yields were increased 16 to 40 per cent in maize and 8 to 9 per cent in sugarbeet. Yield increases did not cover the cost of mulching.

Patel et al. (1973) observed, in irrigated trials with potatoes, that mulch of rice straw, wheat, bhusa (straw), maize stover and sugarcane trash increased yields by 62.8, 45.6, 43.2 and 42.6 per cent respectively as compared with no mulch.

Ravindranath et al. (1974) studied the effect of mulching on growth, yield and water use of sorghum CSH-1 and reported that straw mulching caused significant increase in plant growth characters viz. plant height, leaf area and root and shoot dry matter production and also increased yield attributes such as number of grain and weight of the grains per ear which resulted in higher grain and stover yields as compared to no mulch.

Umrani et al. (1973) reported that using dry grass at the rate of 5 t/ha as a mulch, which was spread just after germination of jowar crop, was effective in conserving soil moisture during the growth period and resulted in yields of 1.73 tonnes grain and 6.39 tonnes fodder per hectare compared with 1.36 and 5.43 tonnes per hectare respectively under no mulch conditions. This increase was 28.00 per cent in case of grain and 18 per cent in case of fodder.

Ali and Prasad (1976) studied the effect of mulches on the yield of rainfed wheat and reported that straw mulch increased the grain yield significantly over no mulch, due to significant increase in number of productive shoots and number of grains per spike.

Mane (1977) found beneficial effects of application of mulch on the growth and yield contributing characters of M-35-1 jowar.

III. Effect of mulches on soil moisture conservation :

Peters (1960) studied the evaporation and transpiration and found that evaporation from the soil surface accounted for as much as 50 per cent of the total water use in areas frequently moistened by summer rains. Kanitkar et al. (1968) observed that about 60 to 70 per cent rain water is lost through surface evaporation from the soils at Solapur.

Moody et al. (1963) studied the influence of straw mulch on soil moisture on corn crop treated with 3 tonnes of wheat straw per acre and observed greater moisture under mulch during the period of high plant requirements. Barkley et al. (1965) reported that straw mulch conserve more soil moisture.

Moisture conservation under mulches in eroded terraced soils of Ranchi was studied by Choudhary and Chattarjee (1967) and observed that soil moisture fell down to only 15 per cent before the mulched treatments were applied. Subsequent sampling at fortnightly intervals indicated significant moisture conservation effects of straw mulch over no mulch treatment.

Chandra *et al.* (1970) studied the effect of organic mulches (leaf and straw) on the yield of groundnut and indicated that an unmulched crop requires 8 irrigations but 2 irrigations can be saved if the crop is mulched.

Pal and Pandey (1969) studied the effect of straw mulch on *jowar*, *bajra* and maize crops at I.A.R.I., New Delhi, and observed that straw mulch could bring a sizeable economy in water use and the green fodder yields were constantly and considerably higher than from other treatments. The effectiveness was owing to the fact that it reduced evaporation from the soil surface in the early stage of crop growth and maintained desirable water balance.

Bond and Willis (1969) studied water evaporation, surface residue rates and placement effects. It was indicated that evaporation of originally wetted packed column of fine sandy loam soil was decreased due to surface application of rye straw of 5.60 to 6.72 t/ha.

Rajput and Singh (1970) studied the efficacy of different mulches in conserving soil moisture in cotton. During the rainless premonsoon season, soil mulch conserved soil moisture to the extent of 40 per cent, polythyelene mulch to the extent of 55 per cent and petrolium mulch to the extent of 15 per cent. Straw and polythyelene mulches resulted in saving irrigation water without any adverse effect on the crop yield.

Bansal *et al*. (1971) studied the effect of mulches on water conservation in maize and pearl millet crops and observed that straw mulch gave highest efficiency of water use (136 kg/ha/cm). Choudhari and Prihar (1972) also observed reduction of moisture losses in the corn crop due to mulches.

Ali and Prasad (1972) reviewed results of experiments on barley. Among the different mulches studied, straw mulch applied at the rate of 4 t/ha was found most effective in moisture conservation as evidenced by increased grain of 1705 kg over no mulch in 1968-70.

Ravindranath *et al*. (1974) studied the effect of mulching on sorghum (C.S.H.-1) observed that the effect of mulching was positive in respect to water use. The number of irrigations, total water requirements and seasonal consumptive use were low under mulch conditions which increased water use efficiency. The increase of water use efficiency by 62.5 per cent with mulching could be due to the supression of weeds, reduction of soil temperature and by checking evaporation losses.

Umrani *et al*. (1973) studied the effect of mulching on conservation of moisture in sorghum crop. The experiment was laid out in medium deep (90 cm) black soil by using dry grass at the rate of 5 t/ha as a mulch on the surface which was spread just after germination of the crop. They observed that mulch resulted in checking the evaporation of moisture from soil, thus making it available for plant growth.

Varma and Mayers (1975) observed influence of surface mulches on soil moisture and found that sorghum stubble mulch applied on the soil surface at the rate of 7.5 t/ha was proved to be the most effective and shown superiority in reducing moisture evaporation.

IV. Effect of mulches on soil temperature :

Mulch farming is associated mainly with moisture conservation where the moisture is a limiting factor. In certain crops, however, soil temperature is also a limiting factor under certain conditions. In the countries where air temperatures are abnormally cool, the soil temperatures are also cool which adversely affect the root growth and crop yields. In the tropical countries the air temperatures sometimes are abnormally high which is also a harmful condition. In such countries, evidences have been found that practice of surface mulching was useful in keeping the soil temperature cooler. Mulch farming helps to maintain the favourable soil temperature, to be useful for healthy growth and higher yields of crops.

Schaller and Evans (1954) observed that soil temperatures were reduced by mulches in the corn crop. Similar observations were made by Clarkson (1960).

Adams (1967) studied the effects of mulches on soil temperature and grain sorghum development. He found that during growing season soil temperatures were in a satisfactory range of plant growth under all the mulches soil temperature at 3 inch straw mulch depth varied from 90 to 95°F under bare soil, to near 80°F under the 2 inch straw mulch from early June to mid-August. Adams (1970) found highly significant effect of mulches on average soil temperatures at 7.6 cm below the soil surface. The increase in average soil temperatures was considered the most important effect of mulch during the first 4 to 6 weeks planting of sorghum and corn crops.

Choudhari and Prihar (1972) observed that straw mulch reduced the maximum soil temperature by 2.6°C in 1970 and 2.3°C in 1971. The reduction of soil temperature and reduction of soil moisture losses resulted in better plant growth and higher yields.

Schmidt (1973) studied the effect of bitumen emulsion on soil temperature and plant yield with light sandy soil. Bitumen emulsion was applied in bands 15 cm wide (1800 litres/ha), 25 cm wide (3000 litres/ha) and over the whole area (6000 litres/ha) to maize and sugarbeet. It was observed that as band width increased, soil temperature at sowing depth increased, emergence and growth were promoted and yields were increased 16 to 40 per cent in maize and 8 to 9 per cent in sugarbeet.

Patel *et al.* (1973) studied the effect of mulches viz. rice straw, wheat *bhusa* (straw), maize stover and sugarcane trash on irrigated potatoes. All mulches gave increased yields, lower the day soil temperature and reduced soil temperature fluctuations.

Ravindranath *et al.* (1974) observed that soil temperatures measured at the top 5 cm depth of soil revealed an average decrement of 4°C under mulch conditions in summer.

Lal (1974) observed that mulching with rice straw and forest litter at the rate of 4 t/ha in maize crop, significantly decreased the maximum soil temperature at depths of 5, 10 and 20 cm. Differences as great as 8°C at 5 cm were recorded during the initial stages of crop growth.

Varma and Mayers (1975) also studied the influence of surface mulches on soil temperatures in *jowar* and found that vegetative mulch or admixture with soil indicated less day variation in temperature. Stubble mulch application at the surface was the most effective in reducing soil temperature during day time.

Mane (1977) observed that mulching with red gram stalks at the rate of 5 t/ha the soil temperatures were lower than unmulched plots.

V. Effect of mulches on weed control :

It was reported by some of the research workers that weeds supressed due to mulching and the crop yields were increased. Chandra Mohan (1970) observed that the growth of weeds was found to be less in mulched (organic) plots of groundnut

Chakraborty (1971) reported that of 9 chemical and cultural methods tested for controlling weeds in potatoes, the greatest reduction in weed population and dry matter and the highest tuber yields per plant resulted from the application of straw mulch.

Patel et al. (1973) reported that in irrigated trials with potatoes, mulch of rice, wheat bhusa, maize stover and sugarcane trash gave effective weed control.

Ravindranath et al. (1974) reported that paddy straw mulch has increased the water use efficiency by 62.5 per cent can be due to supression of weeds, reduction of soil temperature and checking of evaporation losses.

VI. Effect of mulches on uptake of nutrients :

Adams (1970) reported that there were favourable effect of mulch in increased uptake of nutrients reflected in increased above ground vegetative growth in sorghum.

Ali and Prasad (1975) observed that straw mulch was effective in increasing the nutrient uptake and crop yield in pearl millets.

Chapter III

MATERIALS AND METHODS

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Chapter III

MATERIALS AND METHODS

The investigation on the response of two varieties of sorghum viz., CSH-8R and No. 168, to two levels of irrigation (0.50 WUF and 0.75 WUF) with three mulch treatments viz., sugarcane trash, bitumen and no mulch, under summer conditions was carried out by conducting a field experiment. The details of the materials used and the methods adopted during the conduct of the investigation are given in this chapter under different heads as follows.

1. Details of the experimental material :

1.1 Experimental site :

The experiment was carried out on plot number 50 in the instructional farm of the Central Campus Farm, Mahatma Phule Krishi Vidyapeeth, Rahuri during summer 1977.

1.2 Soil :

The soil of the field was well drained, medium black in colour with medium depth (90 cm). The field was uniform and levelled. The representative soil sample of 0-30 cm depth was collected and analysed for the physico-chemical properties such as clay, silt, fine sand, coarse sand, total nitrogen, available P_2O_5, available K_2O, organic carbon, calcium carbonate and pH. The representative soil samples of 0-30 cm and 30-60 cm depth were collected and analysed for physical constants such as field capacity, wilting point and bulk density. The data showing physico-chemical properties of the experimental soil are presented in Table 1.

Table 1 : Physico-chemical composition of the soil (0-30 cm).

Sr.No.	Characteristics	Per cent 0-30 cm		Method used
A.	Physical composition			Pipette Method
	1. Clay	58.75		(Piper, 1966)
	2. Silt	15.75		
	3. Fine sand	9.48		
	4. Coarse sand	6.86		
	5. Textural class	Clayey		
B.	Chemical composition			
	1. Total nitrogen	0.043		Modified Kjeldahl's method (A.O.A.C., 1955).
	2. Available P_2O_5	0.002		Olsen's Method (Olsen, 1954).
	3. Available K_2O	0.032		Flame photometer Method Hanway and Heidal, 1967).
	4. Organic carbon	0.53		Walkley and Black Rapid Titration Method (Piper, 1966).
	5. pH	8.1		Glass Electrode Method (Piper, 1966).
C.	Other details	0-30 cm	30-60 cm	
	1. Field capacity	43.40	44.20	Field Method(Dastane, 1972).
	2. Permanent wilting point	25.40	26.70	Sunflower Method (Dastane, 1972).
	3. Bulk density	1.34	1.37	Core Sampler (Dastane, 1972).

It is seen from the data in Table 1 that the soil used for experimentation was clayey in texture. The chemical composition indicated that the soil was medium in total nitrogen and available P_2O_5 but high in available K_2O. The soil was slightly alkaline in reaction.

1.3 Climatic conditions :

1.3.1 General :

Rahuri is situated at 19°47' north latitude and at 74°82' east longitude. The average height above mean sea level is 525 meters. Considering the existing climate, the area falls in the semi-arid, sub-tropical and transitional zone, with annual rainfall of 475 mm. The distribution of these rains is erratic and the number of rainy days in a year, ranged from 15 to 45 days. Most of the rainfall is received through south-west monsoon. The tract is a part of the rain shadow region, lying at the eastern side of the western ghats. This area experiences the vagaries of monsoon frequently. Annual mean maximum temperature is 37.9°C, with the range from 33°C to 45°C. The annual mean minimum temperature is 17.2°C. It ranges from 3°C to 18°C. The mean relative humidity at 8.00 hours and 17.00 hours is 59 and 35 per cent respectively.

Agro-climatically, this tract falls in low rainfall and dry climatic region. The frequency of famine conditions is once in three years. This being a *rabi* tract, rains received during September are useful for cultivation of unirrigated *rabi* crops like sorghum, wheat, safflower etc. Summer crops are raised on canal or well irrigation.

1.3.2 Nature of season during experimental period :

The climatological data during the crop season (Summer 1977) are presented in Table 2.

Table 2 : Meteorological data recorded during Summer 1977 (February 12 to July 15).

Meteoro-logical week	Month and date	Mean temperature °C		Mean humidity %		Pan evapo-ration mm	Rain-fall mm
		Maximum	Mini-mum	Morning	After-noon		
7. Feb.	12-18	32.6	17.2	47	20	7.4	0.0
8.	19-25	34.6	17.2	62	27	7.9	0.0
9.	26-4 Mar	34.9	15.2	56	18	7.8	0.8
10. Mar.	5-11	35.3	16.5	55	20	8.3	6.4
11.	12-18	36.9	18.4	44	17	9.1	0.0
12.	19-25	38.1	18.6	51	15	10.3	0.0
13.	26-1 Apr	37.6	22.1	50	17	10.6	0.0
14. Apr.	2-8	38.8	21.0	53	22	11.2	0.0
15.	9-15	36.0	17.4	54	20	11.5	0.0
16.	16-22	37.4	22.2	49	17	11.1	0.0
17.	23-29	37.6	21.6	45	23	11.0	-
18.	30-6 May	38.1	19.1	53	19	11.8	-
19. May	7-13	38.7	22.2	61	23	12.7	28.0
20.	14-20	39.2	21.6	68	17	12.3	-
21.	21-27	37.3	23.6	65	26	11.4	-
22.	28-3 June	37.3	22.1	66	25	11.9	-
23. June	4-10	38.3	24.2	71	28	11.8	17.6
24.	11-17	35.0	22.6	80	44	10.9	101.7
25.	18-24	31.8	22.8	89	63	5.9	62.4
26.	25-1 July	29.8	23.2	84	61	5.0	11.2
27. July	2-8	30.5	23.2	80	55	7.2	4.6
28.	9-15	32.4	22.5	79	52	7.2	0.6

Data in Table 2 indicated that no rainfall was received during the germination phase and early growth phase of the crop. The dibbling of jowar was completed by presoaking irrigation.

Subsequently 3 irrigations were given common to all the treatments. After one-month i.e. after application of mulch, the irrigations were given as per the treatments.

The mean maximum temperature, during the season, was in between 29.8°C to 39.2°C and mean minimum temperature was in between 15.2°C to 24.2°C.

1.4 Cropping history of the experimental field :

Details of cropping pattern followed on the experimental field for the last three years are given in Table 3.

Table 3 : Cropping history of the experimental plot for the preceeding three years.

Sr. No.	Year	Kharif	Manuring N P K	Rabi	Manuring N P K	Summer	Manuring
1.	1974-75	-	-	Wheat	125:75:62	-	-
2.	1975-76	Bajra	75:30:20	Wheat	125:75:62	-	-
3.	1976-77	Mung	10:25:0	Wheat	125:75:62	Present experiment on jowar.	

1.5 Experimental details :

The experiment was laid out in split plot design with four replications. Main treatments comprised four combinations of two jowar varieties and two irrigation levels based on the water use factors (WUF). The jowar varieties were CSH-8R and No. 168 and irrigation levels were 0.5 WUF and 0.75 WUF. There were three sub-treatments viz., sugarcane trash mulch, bitumen mulch and no mulch.

Details of the treatments alongwith their representative symbols are presented in Table 4.

Table 4 : Details of the treatments with their symbols.

Details of treatments	Symbols
A. Main treatments	
I. Varieties - 1. CSH-8R	V_1
2. No. 168	V_2
II. Irrigation levels -	
1. 0.50 WUF	I_1
2. 0.75 WUF	I_2
B. Sub-plot treatments	
Mulches - 1. Sugarcane trash @ 5 t/ha	M_1
2. Bitumen @ 2 t/ha	M_2
3. Control	M_3

The gross and net plot sizes were 6.0 x 4.5 meters and 4.2 x 2.7 meters respectively. The plan of layout of experiment with the allocation of treatments to different experimental units is shown in Fig. 1.

1.6 Cultural operations :

The various field operations carried out in the experimental plot, during the season (Summer 1977) are given in Table 5.

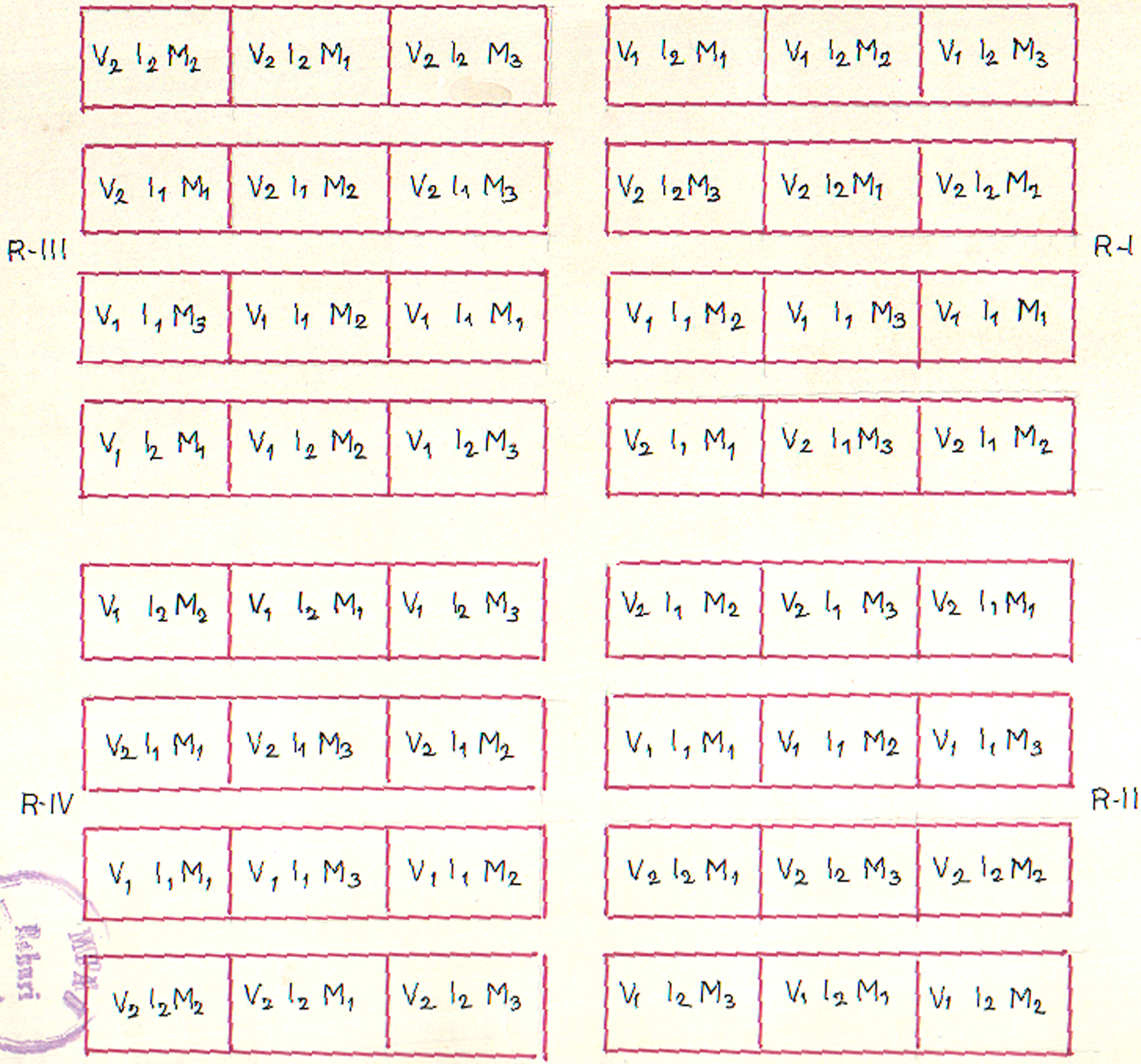

FIG.1. PLAN OF LAYOUT

- DESIGN – SPLIT PLOT
- NO. OF TREATMENTS – i) MAIN PLOT – 4; ii) SUB PLOT – 3; TOTAL – 12
- REPLICATIONS – FOUR
- PLOT SIZE – GROSS 6.00 m x 4.5 m; NET 4.20 m x 2.70 m
- REFERENCES

V_1 — CSH-8R

V_2 — No. 168

I_1 — AT 0.50 WUF

I_2 — AT 0.75 WUF

M_1 — SUGARCANE TRASH MULCH

M_2 — BITUMEN MULCH

M_3 — NO MULCH

Table 5 : Schedule of field operations carried out in the experimental plot during Summer 1977.

Sr.No.	Field operations	Date of operations
1.	Ploughing ...	20-1-1977
2.	Discings (double) ...	25-1-1977
3.	Harrowings (double) ...	28-1-1977
4.	Stubble collection ...	31-1-1977
5.	Marking and layout ...	14-2-1977
6.	Pre-soaking irrigation ...	18-2-1977
7.	Application of fertilizers ...	25-2-1977
8.	Seed treatment ...	25-2-1977
9.	Sowing by dibbling ...	26-2-1977
10.	Post sowing irrigation ...	26-2-1977
11.	First thinning and gap filling ...	10-3-1977
12.	Plant protection - i) Endrin spray ...	10-3-1977
	ii) Endrin spray ...	21-3-1977
13.	Final thinning ...	19-3-1977
14.	Hand weeding ...	24-3-1977
15.	Irrigations : Common ...	26-2, 10-3 & 1-4-1977
	: 0.50 IUF ...	15-4, 29-4, 15-5, 29-5 and 14-6-1977
	: 0.75 IUF ...	10-4, 19-4, 29-4, 9-5, 20-5, 29-5 and 9-6-1977
16.	Top dressing ...	1-4-1977
17.	Removing of side sprouts ...	3-4-1977
18.	Mulching (As per treatment) ...	3-4-1977
19.	Wire netting ...	15-5-1977
20.	Watching (Bird scaring) ...	15-5-1977 to till harvest
21.	Harvesting : i) CSH-8R ...	24-6-1977
	ii) No. 168 ...	3-7-1977

1.7 Seeds and sowing :

The seed of jowar hybrid CSH-8R was obtained from the Director of Farms, Central Campus Farm, Mahatma Phule Krishi Vidyapeeth, Rahuri and the seed of variety No. 168 was obtained from the Sorghum Breeder, Mahatma Phule Krishi Vidyapeeth, Rahuri. The seeds of both the varieties were treated with carbofuron before sowing. The seed was dibbled, keeping the spacing of 45 cm between rows and 15 cm within plants. Five to six seeds were dibbled per hill.

Germination was observed on the 5th day after sowing and was nearly completed in about 9 days. Gap filling was done at 12 days after dibbling. Thinning was done in two stages, first at 12 days and second at 21 days after sowing. At second thinning, only one healthy plant was kept per hill.

1.8 Fertilizer application :

Recommended doses of fertilizers were applied common to all the treatments. Details regarding the time and doses of fertilizers applied are given below.

Time of fertilizer application	Name of the ingradient	Quantity of ingradient/ hectare (kg)	Carrier used
Basal dose	Nitrogen	62.5	Urea
	P_2O_5	75.0	Single super phosphate
	K_2O	62.0	Murate of potash
Top dressing	Nitrogen	62.5	Urea

1.9 Plant protection measures :

Generally during the early stage of crop, shootfly (*Atherigona indica*) is a serious pest of *jowar*. For minimising the incidence of this pest, spraying of 20 E.C. endrin at the rate of 620 ml in 250 litres of water per hectare was carried out after 12 days of sowing, eventhough the carbofuron treated seed was used for sowing. The slight incidence of shootfly (*Atherigona indica*) was observed at first thinning. The moderate incidence of stem borer (*Chillo zorellus*) was noticed at second thinning. The affected plants were removed and spraying of 20 E.C. endrin was taken. As a preventive measures for Army Worm (*Cirphis unipunta*) and Midgefly (*Contarinia sorghicola* Coq) incidence, 10 per cent B.H.C. at the rate of 25 kg per hectare was dusted at the time of 50 per cent flowering. Crop was protected against birds damage by using nylon wire net and keeping regular human watch.

1.10 Intercultivation :

One hand weeding was done, when crop attended the age of one-month.

1.11 Irrigation :

The irrigation application as per treatments was started after the spreading of mulch. During this period of early growth, three common irrigations were given.

Irrigation treatments, involving the climatological approach in this investigation, were scheduled on the basis of pre-determined water use factors, viz. 0.50 WUF and 0.75 WUF. The Water Use Factor is the ratio between evapotranspiration by the crop and actual evaporation from U.S.W.B. Class-I open pan evaporimeter (with wire mesh).

The depth of available moisture was calculated for the effective root zone of jowar i.e. 0 to 60 cm as per the following formula :

$$\text{Depth of available moisture} = \frac{\text{Available moisture} \times \text{Bulk density} \times \text{Effective root zone}}{100}$$

The available moisture was calculated by determining the difference between Field Capacity and Permanent Wilting Point. In order to determine the interval of irrigation, the evaporation values were calculated for each of the Water Use Factor.

Evaporation values for the irrigation treatments are calculated as follows :

$$\text{At 0-30 cm depth} = \frac{43.40 - 25.40}{100} \times 1.34 \times 300 \text{ mm}$$

$$= 72.36 \text{ mm.}$$

$$\text{At 30-60 cm depth} = \frac{44.20-26.70}{100} \times 1.37 \times 300 \text{ mm}$$

$$= 71.02 \text{ mm}$$

$$\text{Total} = 72.36 + 71.02 = 143.38 \text{ mm.}$$

As per the assumption that, the next irrigation to be given, when 50 per cent of the available soil moisture is depleted, 50 per cent of the available soil moisture depletion was worked out as follows :

$$\frac{143.38}{1} \times \frac{50}{100} = 71.69 \text{ i.e. } 72 \text{ mm}$$

Thus, the evaporation values were calculated as follows :

1. At 0.50 WUF, $\frac{72}{1} \times \frac{100}{50} = 144$ mm

2. At 0.75 WUF, $\frac{72}{1} \times \frac{100}{75} = 96$ mm

Thus, irrigations were given when daily evaporation value from standard U.S.W.B. Class-I open pan evaporimeter summed upto 144 mm and 96 mm for 0.50 and 0.75 WUF, respectively.

The quantity of water (72 mm) required to restore the soil moisture to field capacity in the root zone (60 cm) was applied at each irrigation. The quantity of irrigation water was measured with the help of orifice.

1.11.1 Soil moisture studies :

The soil moisture studies were made 24 hours before irrigation and 48 hours after irrigation from 0-30 cm and 30-60 cm soil layers. The samples were taken from two spots in each plot and mixed together. About 50 g soil sample was taken to determine the moisture percentage. The soil moisture was determined by gravimetric method expressed on oven dry weight basis. The soil moistures were dried at 105°C in thermostatic drying oven.

1.11.2 Consumptive Use (C.U.)

Consumptive use of water was calculated by the formula as given by Dastane (1972).

$$U = \Sigma u$$

Where, U = Total seasonal consumptive use.

u = Consumptive use during a given irrigation interval and is worked out by the following formula :

$$u = (Eo \times 0.8) + (M_1 - M_2) + GWC + ER$$

Where, Eo = Evaporation from U.S.W.B. Class-I open pan during the interval from the day of irrigation to the day when sampling in wet soil is possible.

0.8 = A constant to be used with the U.S.W.B. Class-I evaporimeter for medium soils.

M_1 = Soil moisture in the root profile on the day when sampling in irrigated soil is possible.

M_2 = Soil moisture in the root profile on the day just before next irrigation.

GWC = Ground Water Contribution during the interval.

ER = Effective Rainfall during the interval.

1.11.3 Moisture use efficiency :

It is reciprocal of the evapotranspiration ratio. It indicated the amount of produce per unit of water consumed. It is calculated by the formula -

$$MUE = \frac{\text{Yield in q/ha (or kg/ha)}}{\text{Consumptive use of water in mm}}$$

1.12 Mulching :

An organic mulch, sugarcane trash was used for mulching. The sugarcane trash at the rate of 5 m tonnes per hectare was spread uniformly between two crop rows without disturbing the main crop. A liquid mulch, bitumen was used as mulch. Bitumen which is used for the road was melted and sprayed between two rows with the help of water cans at the rate of 2 m tonnes per hectare. Bitumen was sprayed on 25 cm breadth out of 45 cm spacing between two rows to avoid the burning damage to the *jowar* plants from boiling liquid. Thus 20 cm breadth between rows was left uncovered due to application difficulty as mentioned above. Application of mulch was done on 35th day of crop growth.

2. Biometric and other observations :

2.1 Sampling technique :

Five crop lines were selected in each net plot at random and then one plant in each of these selected lines was selected at random with the help of random number tables. Bamboo pegs were fixed near the observation plants thus selected for easy location.

Details of the observations recorded, during the course of the investigation are given in Table 6.

2.2 Growth studies :

The details of the growth observations recorded on the

Table 6 : Details of biometric observations :

Sr. No.	Particulars	Frequency	Days from sowing	Plants observed per net plot
A.	Growth studies :			
1.	Plant count	2	30 At harvest	All plants from net plot
2.	Height of plant	4	30, 60, 90 and at harvest	5
3.	Number of functional leaves per plant	4	30, 60, 90 and at harvest	5
4.	Leaf area	4	30, 60, 90 and at harvest	5
5.	Dry matter per plant	4	30, 60, 90 and at harvest	2
B.	Post harvest studies :			
1.	Length of earhead(cm)		At harvest	5
2.	Girth of earhead(cm)		At harvest	5
3.	Length of peduncle		At harvest	5
4.	Girth of peduncle		At harvest	5
5.	Weight of earhead(gm)		At harvest	5
6.	Grain weight per earhead (g)		At harvest	5
7.	*Bhoosa* weight per earhead (g)		At harvest	5
8.	Number of grains per earhead		At harvest	5
9.	Thousand grain weight(g)		At harvest	5
10.	Grain yield/plot (kg)		At harvest	All plants from net plot
11.	*Kadbi* yield/plot (kg)		At harvest	-do-
12.	Grain to *kadbi* ratio		At harvest	-do-
C.	Chemical studies :			
1.	Plant analysis for nitrogen		At harvest	2
D.	Other studies :			
1.	Soil temperature	1	100	2 spots
2.	Weight of weeds	1	At harvest	Net plot

randomly selected five plants from the net plot during the course of the investigation are as follows :

2.2.1 Plant count :

The initial plant count was recorded after the final thinning at 30 days after sowing and the final plant count was recorded just before the harvest of the crop from the net plot.

2.2.2 Height of the plant :

Height of the plant was taken on 30th day after sowing while other periodical height observations were recorded after 30 days of each successive observation. The height of the plant was measured from ground level to the base of the last fully opened leaf upto the stage of earhead emergence. After the earhead emergence, it was measured from the ground level to the base of earhead.

2.2.3 Number of functional leaves :

Number of fully opened leaves was recorded on the same days on which the height observations were recorded. At 90th day and at harvest, the leaves, which were green more than half of the total leaf area, were recorded as functional leaves.

2.2.4 Leaf area per plant :

For determining the leaf area per plant from each treatment plot, plants taken for the dry matter studies were used. The leaves were separated from stem and were grouped in three classes i.e. big, medium and small. The maximum length and breadth was recorded of a representative leaf from each class.

The leaf area was then calculated by using the formula given by Stickler *et al.* (1961). The total leaf area was calculated by considering the number of leaves in each class and leaf area of representative leaf.

Leaf area = Mean length x Maximum breadth x 0.747.

2.2.5 <u>Leaf area index (LAI)</u> :

The leaf area index was calculated from the data on leaf area per plant at various growth periods according to the following formula given by Watson (1947).

$$LAI = \frac{\text{Leaf area}}{\text{Land area}}$$ (Expressed in same unit).

2.2.6 <u>Total dry matter per plant</u> :

Two plants were taken for dry matter studies at 30, 60, 90 days growth and at harvest. After removing the roots from the ground level, the plants were separated into different components viz., stem and leaves at 30 days and 60 days and stem, leaves and earhead at 90 days and at harvest. These parts were first dried in the sun and subsequently in the thermostatic drying oven with the temperature control at 60 to 65°C. The dry weight of the different components were recorded when they showed constant weight.

3. <u>Growth functions</u> :

The growth analysis studies included, the determination of Absolute Growth Rate (AGR) and Relative Growth Rate (RGR) for plant height and dry weight and Net Assimilation Rate (NAR) for dry weight of plant.

These growth functions were worked out with a view to study the effect of treatments on the physiological determinants of the plant yield. AGR was calculated from the observations on height of plant and total dry matter production per plant with the help of following formula :

$$AGR = \frac{(W_2 - W_1)}{(t_2 - t_1)}$$

Where, W_2 and W_1 refer to the height in cm/dry weight in g per plant at times t_2 and t_1 respectively.

According to Blackman (1919) the increase in dry matter of a plant is a process of continuous compound interest, wherein the increment in any interval adds to the capital for subsequent growth. The rate of increment is called as Relative Growth Rate and was computed from the following formula given by Briggs *et al*. (1920-21).

$$RGR = \frac{(\mathrm{Log}_e W_2 - \mathrm{Log}_e W_1)}{(t_2 - t_1)}$$

Where, W_2 and W_1 refer to the height in cm/dry weight of plant at times t_2 and t_1 respectively.

The NAR is a joint function of the photosynthetic efficiency of leaves, known as Net Assimilation (NA) and Leaf Weight Ratio (LWR). The relationship between leaf area and dry matter accumulation as measured by NAR was studied. The formula suggested by Gregory (1926) was used.

$$NAR = \frac{(W_2-W_1)\ (Log_e L_2 - Log_e L_1)}{(L_2-L_1)\ \ (t_1-t_2)}$$

Where, L_2 and L_1 stand for leaf area of the functional leaves per plant at times t_2 and t_1 respectively. These growth functions were calculated from the data on dry matter and leaf area per plant recorded periodically.

4. Post harvest studies :

Post harvest studies included the characters as follows -

4.1 Length of earhead :

The length of earhead was recorded on the five observation plants by measuring their length from the base to the tip of the earhead.

4.2 Girth of earhead :

The maximum girth of earhead was recorded from the same earheads which were taken for length studies.

4.3 Length of peduncle :

Length of peduncle was recorded from the five observation plants and mean length of peduncle was calculated.

4.4 Diameter of peduncle :

Diameter of peduncle was recorded from the plants which were taken for the length observations. It was measured with the help of Vernier Calliper and mean was calculated.

4.5 Weight of earhead :

Weight of earheads from five observation plants was recorded after drying in the sun and subsequently in the drying oven at 60 to 65°C temperature. From the total weight of five earheads, the mean weight per earhead was calculated.

4.6 Grain weight per earhead :

Earheads from the five observation plants, which were used for earhead weight, were threshed by wooden stick, winnowed and weight of grain was recorded and calculated on per earhead basis.

4.7 Bhoosa weight per earhead :

Weight of bhoosa per earhead was worked out by deducting the mean weight of grains per earhead from the mean weight of earhead.

4.8 Thousand grain weight :

A random sample of 1000-grains was taken from the grains of observation plants and its weight was recorded.

4.9 Grain number per earhead :

A grain produce from the observation plants was divided on per earhead basis and total number of grains per earhead was counted.

5. Yields :

5.1 Grain yield per plot :

Earheads from the net plot were harvested separately for each plot. Earheads were threshed and cleaned. The weights were recorded after sun drying of the grain. The grain yield of observation plants was added to the grain yield of net plot. Then it was converted in quintals per hectare.

5.2 Kadbi yield per plot :

The weight of *kadbi* from each plot was recorded after complete drying in sun for 15 days as per the treatments. The *kadbi* weight of observation plants was added and then converted in quintals per hectare.

5.3 Grain to kadbi ratio :

The ratio of grain to *kadbi* was calculated by dividing the total weight of *kadbi* by the weight of grains.

6.1 Plant analysis :

The plant samples taken for the dry matter estimation at harvest were used to determine, the nitrogen percentage in component plant parts viz., stem, leaves and grains (Piper,1966).

6.2 Uptake studies :

6.2.1 Uptake of nitrogen per plant :

The percentage nitrogen determined from the plant samples taken for dry matter at harvest in grain, stem and leaves was converted into the nitrogen (g) by multiplying the values with average grain weight per earhead, average dry matter of stem and leaves per plant. By summing the nitrogen content in grain, stem and leaves, thus calculated, the total nitrogen (g) was calculated per plant.

6.2.2 Uptake of nitrogen per hectare :

The nitrogen (g) uptake per plant was multiplied by the number of plants per hectare for obtaining the nitrogen uptake per hectare.

6.3 Crude protein percentage in grain :

The percentage nitrogen in grain was multiplied by 6.25 to get the crude protein per cent in grain.

7. Other studies :

7.1 Soil temperature :

Soil temperature was taken at the depth of 10 cm. Three random spots were selected in the net plot for taking the soil temperature. Soil temperature was noted during 14.00 to 15.00 hours on 100th day of growth.

7.2 Weight of weeds :

All the weeds from net plot were collected after harvest of jowar and were dried in sun and then they were dried in oven at 60 to 65°C temperature till constant weight was obtained.

8. Statistical analysis and interpretation of data :

The standard statistical method of "Analysis of Variance" was used for analysing the data statistically. 'F' test of significance was used for testing the null hypotheses. Wherever the treatment effects were significant, the critical difference (C.D) at 5 per cent probability level was calculated. Moreover, suitable graphical illustrations and figures of relevant data are given at appropriate places.

Chapter IV

EXPERIMENTAL FINDINGS

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Chapter IV

EXPERIMENTAL FINDINGS

1. Plant count :

1.1 Initial and final plant count :

The data pertaining to mean initial and final plant population per plot as affected by different treatments are presented in Table 7.

From the data in Table 7, it is revealed that the mean initial and final plant population was 162.69 and 159.40 per plot and 143695.8 and 140653.4 per hectare.

Varieties :

The mean initial and final plant population of two varieties under study did not differ significantly.

Irrigations :

The mean initial plant count was statistically same from both irrigation treatments. Similar was the case even at the time of harvest.

Mulches :

Different mulch treatments under study did not influence the mean initial and final plant number per plot. This indicated that the application of mulch had no effect on plant density at harvest.

Interactions :

None of the interaction effects was found significant. The mean initial and final plant count was not influenced by

Table 7 : Mean initial and final plant count per plot per hectare and per cent theorotical population at harvest as affected by various treatments.

Treatments	Initial plant count		Final plant count		Per cent theoroti-cal popu-lation at harvest
	Per plot	Per hectare	Per plot	Per hectare	
Varieties					
CSH-8R	163.5	144180.8	159.9	141006.2	95.18
No. 168	162.4	143210.8	159.1	140300.7	94.70
F test	NS	NS	NS	NS	
S.E. ±	0.390	343.9	0.335	295.4	
C.D. at 5 %	-	-	-	-	
Irrigations :					
At 0.50 WUF	162.8	143563.5	159.5	140653.5	94.94
At 0.75 WUF	162.8	143563.5	159.5	140653.5	94.94
F test	NS	NS	NS	NS	
S.E. ±	0.390	343.9	0.335	295.4	
C.D. at 5 %	-	-	-	-	
Mulches					
Sugarcane trash	162.4	143210.8	159.6	140741.7	95.00
Bitumen	162.7	143475.4	159.3	140477.1	94.82
No mulch	162.9	143651.7	159.3	140477.1	94.82
F test	NS	NS	NS	NS	
S.E. ±	0.192	169.3	0.280	246.9	
C.D. at 5 %	-	-	-	-	
Interactions					
V x I -F test	NS	NS	NS	NS	
V x M -F test	NS	NS	NS	NS	
I x M - F test	NS	NS	NS	NS	
V x I x M F test	NS	NS	NS	NS	
General mean	162.69	143695.8	159.4	140653.4	

NS = Non-significant.

any of the combinations of varieties, irrigations and mulch treatments.

2. Growth and growth functions :

2.1 Plant height :

Data regarding the average mean plant height on various days of observations as influenced by various treatments are presented in Table 8 and graphically presented in Fig. 2.

The data in Table 8 indicated that the mean height of Jowar increase from 17.02 cm at 30 days to 108.10 cm at harvest. There was maximum growth in terms of height from 30 days to 60 days period. The height on 60th day and on 90th day was 65.52 and 103.24 cm, respectively.

Varieties :

The plant height of the two varieties under study differ significantly on all the days of observations. Hybrid CSH-8R produced significantly more height than variety No. 168.

Irrigations :

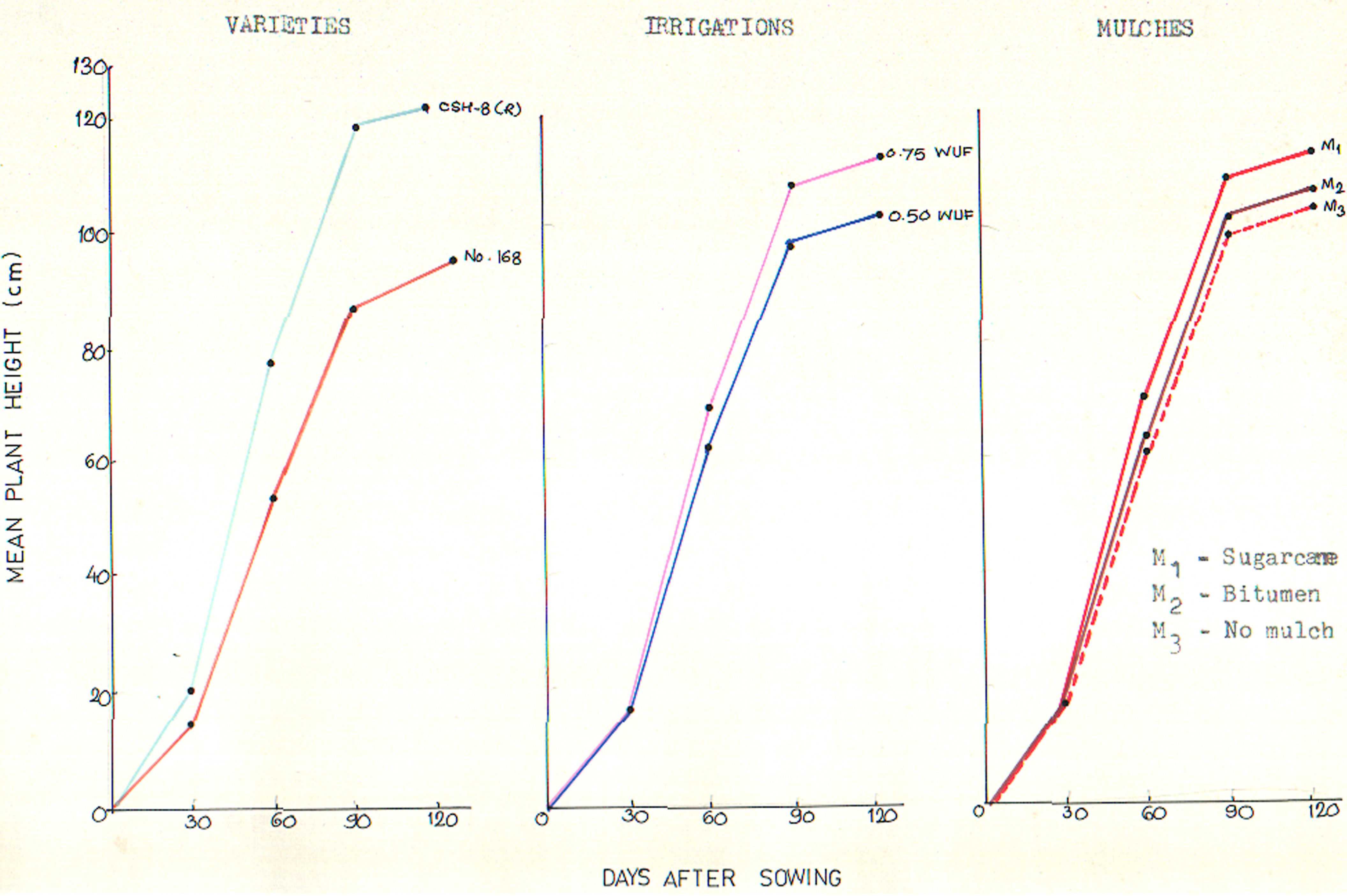
The plant height at 30 days was not influenced significantly by different irrigation treatments. However, on 60th day, 90th day and at harvest the height due to irrigations at 0.75 WUF was significantly more than the height due to water application at 0.50 WUF. The treatments of irrigation were effected after 35 days growth and hence on 30th day the height was statistically same from both the treatments. Data thus clearly indicated that more frequent irrigations during summer

Table 8 : Mean plant height (cm) as affected periodically by various treatments.

Treatments	Days after sowing			
	30	60	90	At harvest
Varieties				
CSH-8R	20.44	76.89	118.36	120.88
No. 168	13.59	54.14	86.63	95.31
F test	Sig.	Sig.	Sig.	Sig.
S.E. ±	0.052	0.090	0.179	0.188
C.D. at 5 %	0.165	0.288	0.574	0.601
Irrigations :				
At 0.50 WUF	17.02	61.73	97.37	103.10
At 0.75 WUF	17.01	69.13	107.61	113.09
F test	NS	Sig.	Sig.	Sig.
S.E. ±	0.052	0.090	0.179	0.188
C.D. at 5 %	-	0.288	0.574	0.601
Mulches :				
Sugarcane trash	16.99	71.26	108.64	113.47
Bitumen	17.07	62.58	101.67	106.91
No mulch	16.98	62.90	99.42	103.90
F test	NS	Sig.	Sig.	Sig.
S.E. ±	0.052	0.094	0.225	0.264
C.D. at 5 %	-	0.274	0.656	0.770
Interactions				
V x I F test	Sig.	Sig.	Sig.	Sig.
V x M F test	NS	Sig.	Sig.	Sig.
I x M F test	NS	NS	NS	NS
V x I x M F test	NS	NS	NS	NS
General mean	17.02	65.52	103.25	108.10

NS = Non-significant. Sig. = Significant.

FIG.2 MEAN PLANT HEIGHT (cm) AS INFLUENCED BY VARIOUS TREATMENTS PERIODICALLY



helped in better growth of jowar than the irrigation with lesser frequency.

Mulches :

Prior to the application of mulch i.e. on 30th day, the height of plant was not influenced significantly. However, during further growth, the height differred significantly due to different mulch treatments. On 60th day, the use of sugarcane trash as mulch helped in increasing the plant height significantly than bitumen mulch and no mulch. The latter two were on par. However, on 90th day and at harvest, all the three mulch treatments showed significant difference in plant height. Sugarcane trash produced maximum height followed by bitumen. The minimum and significantly less height was observed from the plots without mulch.

Interactions :

Varieties and irrigations interaction had significant effect on mean height of jowar plant on all the days of observations. The relevant data are presented in Table 9.

The data in Table 9 indicated that on 30th day, the height of the CSH-8R was significantly more than the height of variety No. 168, at both the levels of irrigation application. The significant difference between the effects of two irrigation treatments in both the varieties under the study was not observed. It may be pointed out that the irrigation treatments were not effected on the day of observation.

Table 9 : Mean plant height (cm) of *jowar* as affected periodically by varieties x irrigation.

Days after sowing	Varieties	Irrigations	
		0.50 WUF	0.75 WUF
30	CSH-8R	20.52	20.36
	No. 168	13.51	13.67
	F test	Sig.	-
	S.E. ±	0.052	-
	C.D. at 5 %	0.165	-
60	CSH-8R	74.80	78.91
	No. 168	45.58	59.70
	F test	Sig.	-
	S.E. ±	0.090	-
	C.D. at 5 %	0.288	-
90	CSH-8R	114.80	121.92
	No. 168	79.97	93.31
	F test	Sig.	-
	S.E. ±	0.179	-
	C.D. at 5 %	0.574	-
At harvest	CSH-8R	117.25	124.52
	No. 168	88.96	101.66
	F test	Sig.	-
	S.E. ±	0.188	-
	C.D. at 5 %	0.601	-

On 60th, 90th day and at harvest, the mean plant height was influenced significantly by the combination of irrigations and varieties. Hybrid CSH-8R showed significantly more height than variety No. 168 at both the levels of irrigation. Further, irrigation application at 0.75 WUF was effective in increasing the plant height than the height due to irrigation at 0.50 WUF in case of both the varieties under study.

The interaction effects of varieties and mulch treatments were noticed on plant height on all the days of observations except on 30th day. The relevant data are presented in Table 10.

The data in Table 10 revealed that the height of hybrid CSH-8R on all the three stages of observation was significantly more than No. 168 in all the mulch treatments. Sugarcane trash mulch proved beneficial in increasing the plant height than bitumen and no mulch in both the varieties at all the stages of observation. Use of bitumen mulch helped in significantly increasing the plant height of both the varieties than no mulch on 90th day and at harvest. However, there was no such difference on 60th day of growth.

None of the other interaction effect was observed.

2.2 Number of functional leaves :

The data regarding the mean number of functional leaves per plant at various stages of crop growth as influenced by various treatments are presented in Table 11 and graphically shown in Fig. 3.

Table 10 : Mean plant height (cm) of jowar as affected periodically by varieties x mulches.

Days after sowing	Varieties	Mulches: Sugarcane trash	Bitumen	No mulch
60	CSH-8R	80.87	74.95	74.86
	No. 168	61.65	50.82	50.95
	F test	Sig.		
	S.E. ± *	0.067		
	**	0.188		
	C.D. at 5 % *	0.202		
	**	0.548		
90	CSH-8R	125.79	116.23	113.07
	No. 168	91.50	87.11	85.77
	F test	Sig.		
	S.E. ±	* 0.446		
		** 0.449		
	C.D. at 5 %	* 1.340		
		** 1.312		
At harvest	CSH-8R	128.29	119.07	115.30
	No. 168	98.66	94.76	92.51
	F test	Sig.		
	S.E. ±	* 0.506		
		** 0.528		
	C.D. at 5%	* 1.514		
		** 1.541		

Note - * The comparison of two varieties at the same mulch treatment.

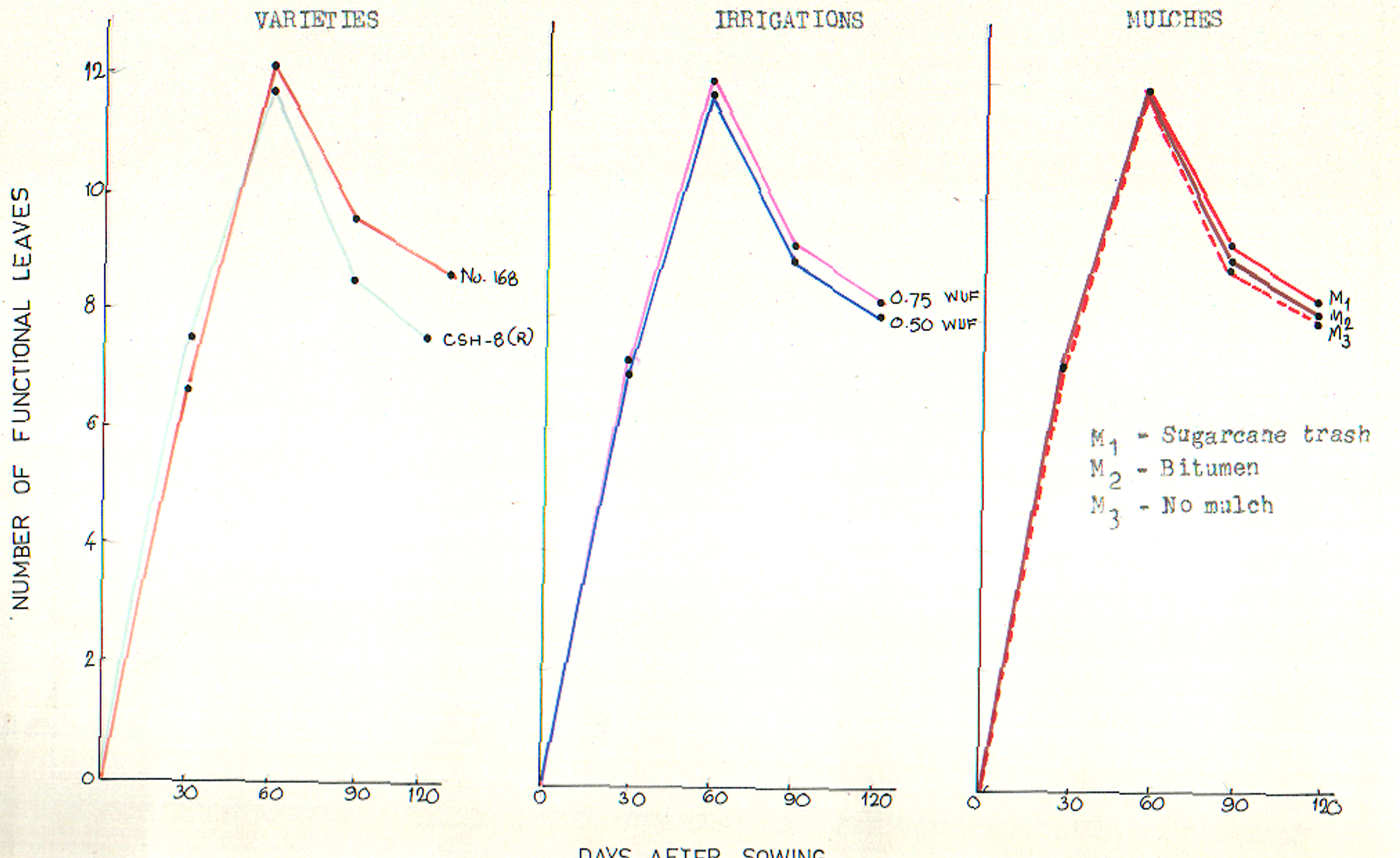
** The comparison of two mulch treatments at the same variety.

Table 11 : Mean number of functional leaves per plant as affected periodically by various treatments.

Treatments		Days from sowing			
		30	60	90	At harvest
<u>Varieties</u> :					
CSH-8R		7.52	11.58	8.45	7.53
No. 168		6.63	12.04	9.52	8.57
F test		Sig.	Sig.	Sig.	Sig.
S.E. ±		0.031	0.020	0.013	0.031
C.D. at 5 %		0.099	0.065	0.041	0.099
<u>Irrigations</u> :					
At 0.50 IW/CPE		6.99	11.76	8.[illegible]	7.95
At 0.75 IW/CPE		7.05	11.87	9.10	8.15
F test		NS	Sig.	Sig.	Sig.
S.E. ±		0.031	0.020	0.013	0.031
C.D. at 5 %		-	0.065	0.041	0.099
<u>Mulches</u> :					
Sugarcane trash		7.13	11.87	9.16	8.23
Bitumen		7.04	11.81	8.93	7.99
No mulch		7.04	11.77	8.95	7.92
F test		NS	NS	Sig.	Sig.
S.E. ±		0.034	0.030	0.026	0.021
C.D. at 5 %		-	-	0.075	0.061
<u>Interactions</u> :					
V x I	F test	NS	NS	Sig.	NS
V x M	F test	NS	NS	NS	NS
I x M	F test	NS	NS	NS	NS
V x I x M	F test	NS	NS	NS	NS
General mean		7.08	11.82	9.01	8.05

NS = Non-significant. Sig. = Significant.

FIG. 3 MEAN NUMBER OF FUNCTIONAL LEAVES AS INFLUENCED BY VARIOUS TREATMENTS PERIODICALLY



The data in Table 11 evidenced that the leaf number was maximum at 60 days growth. It was 11.82 per plant as against 7.08 at 30 days growth. The mean leaf number was reduced after 60th day and it was 9.01 and 8.05 on 90th day and at harvest, respectively. This reduction in leaf number was due to the drying of leaves after 60th day growth.

Varieties :

The number of leaves per plant of the two varieties under study differred significantly at all the stages of crop growth. Hybrid CSH-8R produced more number of functional leaves on 30th day, while variety No. 168 produced more number of functional leaves on subsequent stages of growth i.e. on 60th, 90th day and at harvest.

Irrigations :

The number of leaves per plant on 30th day was not influenced significantly by the irrigation treatments as the treatments were not effected upto the day of observations. However, on 60th day, 90th day and at harvest, the number of functional leaves was significantly more due to irrigation applied at 0.75 WUE than irrigation applied at 0.50 WUE. Data thus clearly indicated that more frequent irrigations during summer helped in better vegetative growth of jowar than the irrigations applied with lesser frequency.

Mulches :

Prior to application of mulch i.e. on 30th day after sowing and on 60th day after sowing, the functional leaves did not influence significantly. However, during the further growth, the number of functional leaves differred significantly due to influence of different mulch treatments. On 90th day, the use of sugarcane trash mulch helped in producing significantly more number of functional leaves than bitumen and no mulch treatments. The latter two were on par. However at harvest, all the three mulch treatments showed significant influence. Sugarcane trash produced maximum number of functional leaves followed by bitumen and the minimum and significantly less number was observed in no mulch treatment.

Interactions :

Varieties and irrigations interaction had significant effect on number of functional leaves of jowar at 90th day only. The relevant data are presented in Table 12.

Table 12 : Mean number of functional leaves per plant at 90th day from sowing as affected by varieties and irrigations combinations.

Varieties	Irrigations	
	0.50 IW/CPE	0.75 IW/CPE
CSH-8R.	8.31	8.60
No. 168	9.45	9.60
F test	Sig.	
S.E. ±	0.013	
C.D. at 5 %	0.041	

The data indicated that the more frequent irrigations to variety No. 168 produced significantly more number of functional leaves than hybrid CSH-8R with lesser frequency of irrigation.

None of the other interactions was found significant.

2.3 Leaf area :

Data pertaining to mean leaf area per plant as affected, at various stages of crop growth, by various treatments are presented in Table 13 and graphically shown in Fig. 4.

The data in Table 13 showed that the mean leaf area per plant was maximum of 34.33 dm^2 on 60th day of growth and thereafter it was reduced to 29.21 dm^2 and 23.32 dm^2 on 90th day and at harvest respectively. This reduction in leaf area per plant after 60th day was probably because of the reduction in leaf number per plant with the advancement of age of the crop.

Varieties :

Amongst the two varieties under study, hybrid CSH-8R showed significantly maximum leaf area per plant at all the stages of crop growth as compared with the variety No. 168. The maximum leaf area was produced at flowering i.e. on 60th day after sowing in both the varieties.

Irrigations .

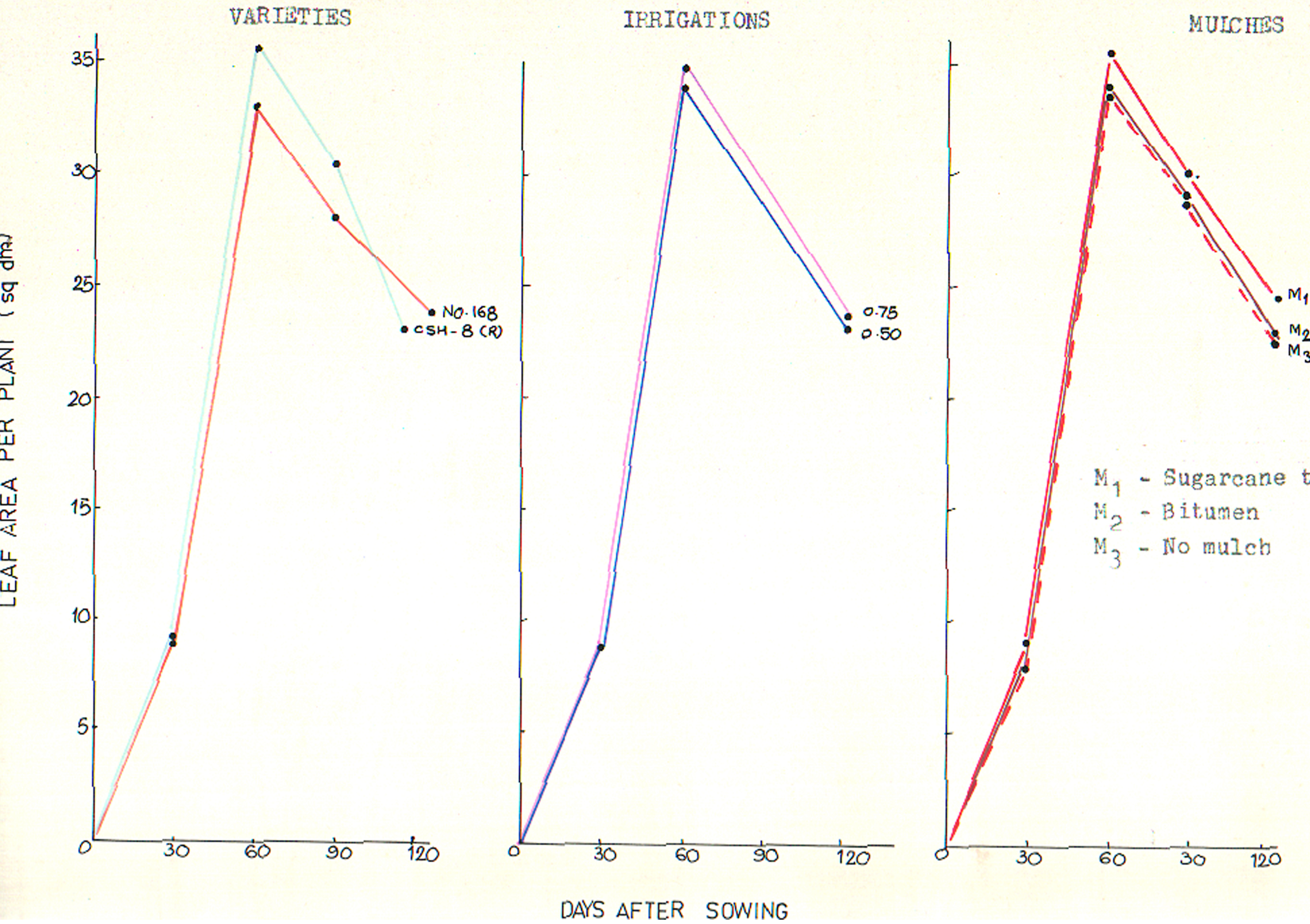
The leaf area per plant on 30th day i.e. at grand growth stage was not influenced significantly by the irrigation treatments as the irrigation treatments were not started. The difference in leaf area was significant at flowering, grain filling and at harvest and was more due to irrigations

Table 13 : Mean leaf area (dm^2) per plant as affected periodically by various treatments.

Treatments		Days after sowing			
		30	60	90	At harvest
Varieties :					
CSH-8R		9.20	35.60	30.41	22.95
No. 168		8.78	33.05	28.00	23.68
F test		Sig.	Sig.	Sig.	Sig.
S.E. ±		0.036	0.069	0.103	0.056
C.D. at 5 %		0.115	0.220	0.329	0.180
Irrigations :					
At 0.50 WUF		9.01	33.89	28.35	22.95
At 0.75 WUF		8.97	34.76	30.06	23.68
F test		NS	Sig.	Sig.	Sig.
S.E. ±		0.036	0.069	0.103	0.056
C.D. at 5 %		-	0.220	0.329	0.180
Mulches :					
Sugarcane trash		9.03	35.36	30.08	24.35
Bitumen		8.94	33.88	28.83	22.82
No mulch		8.99	33.74	28.71	22.77
F test		NS	Sig.	Sig.	Sig.
S.E. ±		0.054	0.051	0.078	0.061
C.D. at 5 %		-	0.148	0.227	0.177
Interactions					
V x I	F test	NS	NS	Sig.	Sig.
V x M	F test	NS	Sig.	NS	Sig.
I x M	F test	NS	NS	Sig.	NS
V x I x M	F test	NS	NS	NS	NS
General mean		9.00	34.33	29.21	23.32

NS = Non-significant. Sig. = Significant.

FIG. 4 MEAN LEAF AREA PER PLANT (dm^2) AS INFLUENCED BY VARIOUS TREATMENTS PERIODICALLY.



at 0.75 WUF than at 0.50 WUF. Thus the data indicated beneficial effect in increasing the leaf area due to more frequent irrigations.

Mulches :

The leaf area per plant was not influenced significantly at grand growth stage, at this stage, however, the mulches were not applied. There was significant increase in the leaf area due to sugarcane trash mulch at flowering, grain filling and at harvest over bitumen and no mulch treatments. Bitumen and no mulch treatments were statistically on par.

Interactions :

None of the interaction was found statistically significant on 30th day.

The interactive effects of irrigation levels and varieties however, found significant at 90th day and at harvest. The data regarding this are presented in Table 14.

Table 14 : Mean leaf area (dm^2) per plant as affected periodically by varieties x irrigations.

Days after sowing	Varieties	Irrigations 0.50 WUF	Irrigations 0.75 WUF
90 days	CSH-8R	29.78	31.04
	No. 168	26.92	29.08
	F test	Sig.	
	S.E. ±	0.103	
	C.D. at 5 %	0.329	
At harvest	CSH-8R	22.68	23.22
	No. 168	23.23	24.14
	F test	Sig.	
	S.E. ±	0.056	
	C.D. at 5 %	0.180	

It is seen from the data in Table 14 that at 90 days growth, hybrid CSH-8R applied with irrigations at 0.75 WUF produced maximum and significantly more leaf area per plant than any other combination. The minimum and significantly less leaf area was produced by variety No. 168 with irrigation at 0.50 WUI.

At harvest, however, the significantly more leaf area was observed in case of variety No 168 with irrigation application at 0.75 WUF. It was followed by the same variety with less number of irrigations and hybrid CSH-8R with more frequency of irrigation. The latter two combinations were on par. The minimum and significantly less leaf area was observed in case of the combined effects of less number of irrigation to hybrid CSH-8R.

The mean leaf area per plant was also affected significantly by the combined effect of varieties and mulches at 60 days growth and at harvest. The data pertaining to which are presented in Table 15.

It is seen from the data in Table 15 at 60 days growth the mean leaf area per plant was more in case of hybrid CSH-8R than variety No. 168 with all the mulch treatments. In case of both the varieties under study, the sugarcane trash mulch was effective in producing more leaf area per plant than the other two mulch treatments which were on par. Maximum leaf area per plant was observed in case of hybrid CSH-8R with sugarcane trash mulch.

Table 15 : Mean leaf area (dm^2) per plant as affected periodically by varieties x mulches.

Days after sowing	Varieties		Mulches		
			Sugarcane trash	Bitumen	No mulch
60 days	CSH-8R		36.44	35.28	35.05
	No. 168		34.28	32.49	32.40
	F test		Sig.		
	S.E. ±	*	0.126		
		**	0.101		
	C.D. at 5 %	*	0.386		
		**	0.292		
At harvest	CSH-8R		24.17	22.34	22.33
	No. 168		24.54	23.31	23.21
	F test		Sig.		
	S.E. ±	*	0.027		
		**	0.121		
	C.D. at 5 %	*	0.080		
		**	0.354		

Note : * The comparison of two varieties with the same mulch treatment.

** The comparison of two mulch treatments with the same variety.

At harvest, variety No. 168 showed significantly more leaf area in all the mulch treatments studied than hybrid CSH-8R. Sugarcane trash mulch was effective in increasing leaf area per plant significantly than other two mulch treatments which were on par.

The mean leaf area per plant at 90 days growth was significantly influenced by the combined effect of irrigation levels and mulch treatments. The data of which are presented in Table 16.

Table 16 : Mean leaf area (dm^2) per plant at 90th day after sowing as affected by irrigations x mulches.

Treatments	Sugarcane trash	Bitumen	No mulch
0.50 WUF	29.02	28.15	27.89
0.75 WUF	31.14	29.52	29.53

S.E. for the comparison of two irrigation levels at the same mulch treatments. ... 0.194

C.D. 0.595

S.E. for the comparison of two mulch treatments at the same irrigation levels 0.156

C.D. 0.456

It is observed from the data in Table 16 that the more number of irrigations applied at 0.75 WUF helped in increasing the leaf area per plant at 90 days than less number of irrigations in all the mulch treatments. Sugarcane trash mulch helped in producing significantly more leaf area per plant than other mulch treatments in both the levels of irrigations. Bitumen mulch did not differ from control in producing leaf area in both the irrigation levels.

2.4 Leaf Area Index (LAI) :

The data regarding LAI as influenced periodically by various treatments are presented in Table 17.

Table 17 : Mean leaf area index as affected periodically by various treatments.

Treatments	Days from sowing			
	30	60	90	At harvest
Varieties :				
CSH-8R	1.36	5.27	4.51	3.40
No. 168	1.30	4.90	4.15	3.51
Irrigations :				
0.50 WUE	1.33	5.02	4.20	3.40
0.75 WUE	1.33	5.15	4.45	3.51
Mulches :				
Sugarcane trash	1.33	5.24	4.46	3.61
Bitumen	1.32	5.02	4.27	3.38
No mulch	1.33	5.00	4.25	3.37
General mean	1.33	5.08	4.33	3.45

The data in Table 17 indicated that the LAI was maximum (5.08) on 60th day of observation and subsequently it was reduced to 4.33 and 3.45 on 90th day and at harvest respectively.

During the period of 30 to 60 days growth, in terms of leaf area as LAI, was increased from 1.33 on 30th day to 5.08 on 60th day.

Varieties :

The data indicated that hybrid CSH-8R showed more LAI on 30th, 60th and 90th day growth than variety No. 168. While at harvest, LAI was more in case of variety No. 168 than hybrid CSH-8R.

Irrigations :

The LAI was not influenced on 30th day of growth. Subsequently on 60th and 90th day and at harves-t LAI was more due to irrigations applied at 0.75 WUF than irrigations applied at 0.50 WUF.

Mulches :

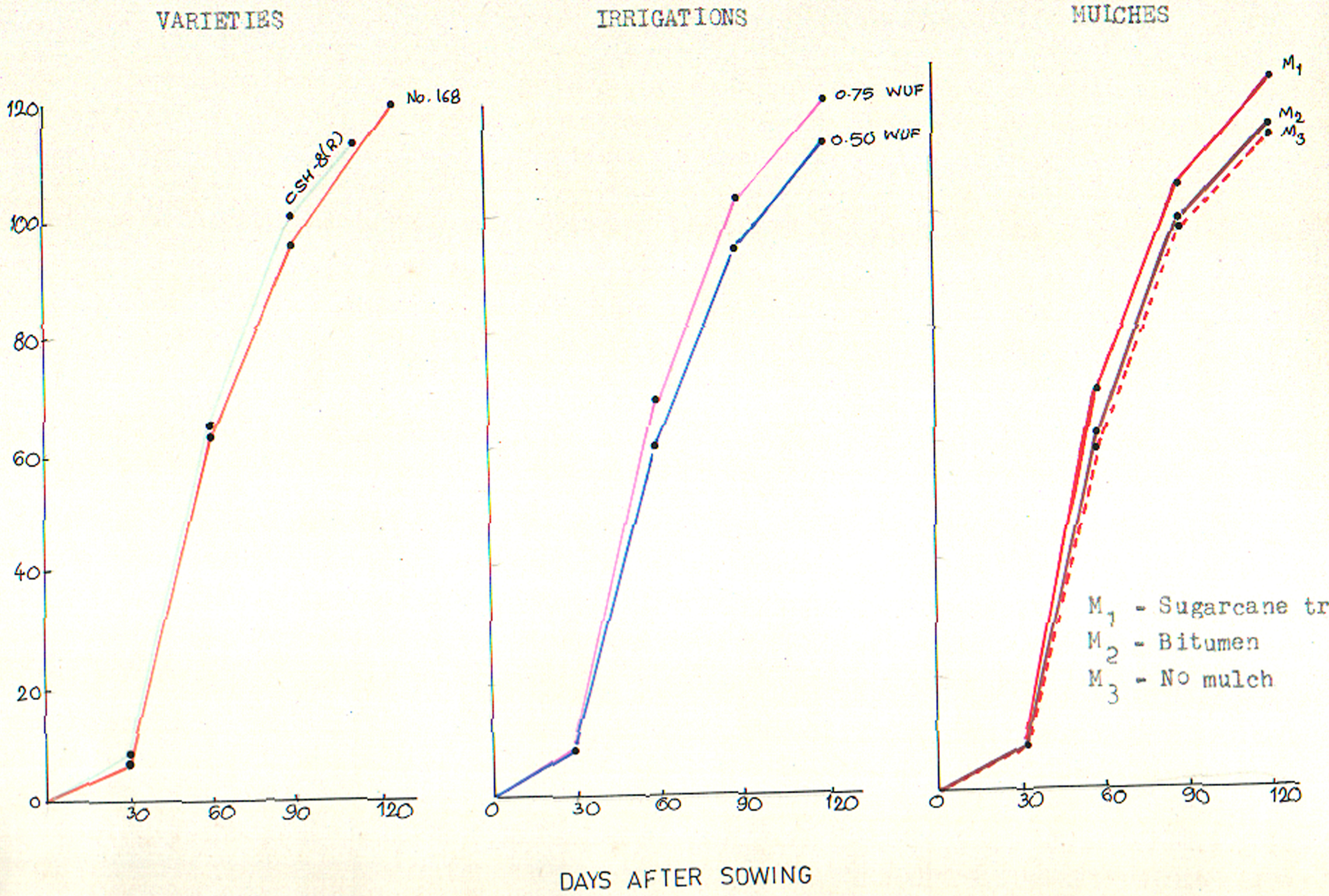
The LAI was more or less equal on 30th day of growth in all the mulched treatments as the treatments were not effected. There was increase in the IAI in the treatment of sugarcane trash mulch at all the stages of observations. There was no influence of bitumen mulch over control.

2.5 Dry matter per plant and its constituents :

Data regarding mean dry matter per plant and its components as affected periodically by various treatments are presented in Table 18 and graphically shown in Fig. 5.

It is evident from the Table 18 that the dry matter was increased with the advancement of the age of the crop. On 30th

FIG.5 MEAN DRY MATTER PER PLANT (g) AS INFLUENCED BY VARIOUS TREATMENTS PERIODICALLY



day, the total dry weight per plant was 7.92 g while at 60 days growth, it was increased to 64.31 g. At this stage, maximum dry matter per plant was contributed by leaves and minimum of 6.50 g by earhead. At 90 days growth, the total dry matter was increased to 98.75 g, out of which, maximum (37.07 g) was contributed by reproductive parts followed by that of stem (31.71 g). Minimum of 29.93 g was contributed by leaves. At harvest, the total dry matter per plant was 115.49. Out of this maximum of 46.96 g was contributed by earhead. The contribution of stem was 37.35 g while 31.62 g by leaves per plant.

<u>Varieties</u> :

The dry matter per plant of the two varieties under study differred significantly on 30th day of growth. Hybrid CSH-8R produced significantly more dry weight than variety No. 168.

At 60 days, the dry weight contribution by the reproductive part differred significantly, while it was on par in case of dry matter due to stem and leaves in case of both the varieties under study. Dry matter of earhead was significantly higher of hybrid CSH-8R than variety No. 168.

At 90 days, hybrid CSH-8R produced significantly more dry weight of all three components than variety No. 168. Total dry weight was also more of hybrid CSH-8R than variety No. 168.

At harvest, total dry weight per plant was more in case of variety No. 168. The dry weight of stem and leaves of the variety No. 168 was significantly more than that of hybrid CSH-8R. In contrast, the dry weight of earhead of hybrid CSH-8R was significantly more than the earhead weight of variety No. 168.

Irrigations :

Total dry weight at 30 days growth did not differ due to irrigation treatments. However, at this stage the treatments were not effected.

At 60 days and 90 days of growth, the dry weight of all the three components was significantly more due to irrigations at 0.75 WUF than irrigations at 0.50 WUF. Total dry weight per plant was also more due to irrigations at 0.75 WUF.

The dry weights of stem, leaves and earhead were significantly more due to irrigations at 0.75 WUF than due to irrigations at 0.50 WUF. The total dry weight per plant was thus more in case of more number of irrigations.

Mulches :

The total dry weight per plant did not differ significantly at 30 days growth due to mulch treatments. However, at this stage mulch treatments were not effected.

At 60 days and 90 days growth stages, the mulch of sugarcane trash was responsible for increasing significantly the dry weight of different components viz. stem, leaves and reproductive part than the other mulch bitumen and no mulch. The latter two treatments were on par as regards the stem, leaves and earhead dry weight at both the stages of observations.

The dry weights of stem, leaves and earhead per plant in sugarcane trash mulch were significantly more than the other two mulch treatments. The dry weights of all the three components were statistically on par, incase of bitumen mulch and no mulch treatments.

Interactions :

The interaction effects of varieties and irrigations produced significant differences in dry weight of stem and leaves at 60 days growth and in dry weight of stem, leaves and earhead at 90 days growth and in dry weight of leaves and earhead at harvest. The data of which are presented in Table 19.

Table 19 : Mean dry matter (g) of different plant parts periodically affected by varieties x irrigation levels.

Days from sowing	Plant part	Varieties	Irrigation levels 0.50 WUF	0.75 WUF	S.E.±	C.D. at 5 %
60	Stem	CSH-8R	25.44	28.75	0.085	0.271
		No. 168	25.09	29.14		
	Leaves	CSH-8R	30.70	31.37	0.088	0.283
		No. 168	29.04	33.19		
90	Stem	CSH-8R	28.49	30.94	0.054	0.174
		No. 168	32.24	35.29		
	Leaves	CSH-8R	28.55	29.46	0.057	0.183
		No. 168	28.64	33.03		
	Reproductive parts	CSH-8R	40.82	44.13	0.089	0.268
		No. 168	30.88	32.45		
At harvest	Leaves	CSH-8R	26.86	30.24	0.217	0.694
		No. 168	33.74	35.63		
	Earhead	CSH-8R	49.76	51.08	0.151	0.484
		No. 168	41.87	45.13		

The data in Table 19 revealed that variety No. 168 when irrigated at 0.75 WUF produced significantly more dry weight of stem at 60 days than the other three combinations. It was followed by CSH-8R hybrid irrigated at 0.75 WUF. However, at 0.50 WUF No. 168 produced significantly less dry weight of stem than hybrid CSH-8R. Similar trend was also noticed in case of dry weight of leaves at 60 days growth.

The data on dry weight of stem at 90 days growth revealed that the stem weight of No. 168 variety with irrigations at 0.75 WUF was significantly more than other three combinations. It was followed by stem dry weight of same variety with irrigations at 0.50 WUF. In case of both the varieties, irrigations at 0.75 WUF produced more dry weight of stem than irrigations at 0.50 WUF.

The data on dry weight of leaves indicated that variety No. 168 with irrigations at 0.75 WUF produced maximum and significantly more dry weight than other combinations. It was followed by hybrid CSH-8R with irrigations at 0.75 WUF. Variety No. 168 produced significantly more dry weight of leaves than hybrid CSH-8R at both the levels of irrigation applications.

The dry weight of reproductive parts at 90 days was maximum and significantly more of hybrid CSH-8R, irrigated at 0.75 WUF than other combinations. At both the levels of irrigation, hybrid CSH-8R showed maximum dry weight of earhead than variety No. 168.

At harvest, the dry weight of leaves was maximum and significantly more of variety No. 168 with irrigations at 0.75 WUF than rest of the combinations. It was followed by the same variety with lesser frequency of irrigation. The dry weight of earhead at harvest was maximum in case of hybrid CSH-8R with higher frequency of irrigation than rest of the combinations. The same hybrid with irrigations at 0.50 WUF produced earhead weight which was significantly more than variety No. 168 applied with irrigation at both the levels. In the latter two treatments irrigation application of 0.75 WUF helped in producing significantly more dry weight of stem than due to irrigation at 0.50 WUF.

The data pertaining to the dry weight of leaves and reproductive part at 60 days and that of earhead weight at harvest as influenced by varieties and mulches combinations are presented in Table 20.

Table 20 : Mean dry matter (g) of different plant parts periodically affected by varieties x mulches.

Plant parts	Varieties	Mulches: Sugarcane trash	Bitumen	No mulch	* S.E.±	C.D. at 5 %	+ S.E.±	C.D. at 5%
60 days from sowing								
Leaves	CSH-8R	32.16	30.76	30.65	0.199	0.600	0.189	0.554
	No. 168	32.82	30.36	30.15				
Reproductive parts	CSH-8R	7.48	6.61	6.63	0.136	0.408	0.136	0.396
	No. 168	6.19	4.64	4.72				
At harvest								
Earhead	CSH-8R	53.43	49.07	48.74	0.269	0.831	0.201	0.587
	No. 168	45.38	42.67	42.45				

Note : * For the comparison of two varieties/irrigation levels at the same mulch treatments.

\+ For the comparison of two mulch treatments at the same varieties/irrigation levels.

The data in Table 20 showed that hybrid CSH-8R produced significantly more dry weight of leaves at 60 days than variety No. 168 with the use of sugarcane trash mulch. However, such difference in two varieties was not observed in case of other two mulch treatments. In case of both the varieties, sugarcane trash mulch was responsible in producing more dry weight of leaves than other two mulch treatments. The latter two mulch treatments were on par.

As regards the dry weight of earhead, it was significantly more of hybrid CSH-8R than variety No. 168 in all the three mulch treatments. In case of both the varieties, use of sugarcane trash was useful in increasing earhead dry weight than other two mulch treatments which were on par.

The earhead weight at harvest also significantly influenced by combined effect of varieties and mulch treatments. In case of all mulch treatments hybrid CSH-8R produced significantly more earhead weight at harvest than variety No. 168. At harvest, sugarcane trash mulch produced significantly more dry weight of earhead than rest of the mulch treatments, in case of both the varieties under study. Further, the bitumen mulch produced statistically the same earhead weight to that of control in both the varieties. Maximum earhead weight was observed in case of hybrid CSH-8R grown with sugarcane trash mulch.

The mean dry weight of stem and earhead at 60 days growth and earhead weight at 90 days growth and at harvest was influenced significantly by irrigations and mulches combinations, the data of which are presented in Table 21.

Table 21 : Mean dry weight (g) of stem and earhead at 60 days and that of earhead at 90 days as influenced by irrigations x mulches.

Plant part	Varieties/ Irrigations	Mulches			*		+	
		Sugarcane trash	Bitumen	No mulch	SE ±	C.D. at 5 %	SE ±	C.D. at 5 %
60 days from sowing								
Stem	0.50 WUF	27.51	24.05	24.23	0.233	0.695	0.244	0.714
	0.75 WUF	32.06	27.48	28.54				
Reproductive parts	0.50 WUF	6.30	5.39	5.44	0.136	0.408	0.136	0.396
	0.75 WUF	7.37	5.86	5.90				
90 days from sowing								
Reproductive parts	0.50 WUF	37.47	34.86	35.22	0.201	0.627	0.198	0.579
	0.75 WUF	39.44	37.73	37.69				
At harvest								
Earhead	0.50 WUF	48.73	44.95	44.77	0.269	0.831	0.201	0.587
	0.75 WUF	51.05	46.86	46.49				

Note : * For the comparison of two varieties/irrigationlevels at the same mulch treatments.

\+ For the comparison of two mulch treatments at the same varieties/irrigation levels.

The data in Table 21 revealed that irrigations at 0.75 WUF produced significantly more dry weight of stem and earhead at 60 days growth than irrigations at 0.50 WUF with all the three mulch treatments. Use of sugarcane trash mulch produced significantly more dry weight of stem and earhead at 60 days growth than other two mulch treatments at both the levels of irrigations. The latter two mulch treatments were on par. The similar trend was noticed in respect of dry weight of earhead at 90 days and at harvest.

3. Growth functions :

3.1 Plant height :

3.1.1 Absolute Growth Rate of plant height .

Data on mean periodical AGR of plant height (cm) per day as influenced by different treatments are given in Table 22.

Table 22 : Mean AGR of plant height (cm) per day during various growth periods as affected by various treatments.

Treatments	Days from sowing	
	31 to 60	61 to 90
Varieties :		
CSH-8R	1.88	1.38
No. 168	1.35	1.08
Irrigations :		
0.50 WUF	1.49	1.19
0.75 WUF	1.74	1.29
Mulches :		
Sugarcane trash	1.81	1.24
Bitumen	1.51	1.31
No mulch	1.53	1.22
General mean	1.62	1.23

The data in Table 22 showed that mean AGR of plant height per day between 31-60 and 61-90 days growth periods was 1.62 cm and 1.23 cm respectively which indicated that AGR of plant height was maximum during 30-60 days period.

Varieties :

Mean AGR of plant height was more in case of hybrid CSH-8R than variety No. 168 during both the periods under study.

Irrigations :

The irrigations applied at 0.75 WUF increased the mean AGR of plant height during both the periods under study than irrigations applied at 0.50 WUF.

Mulches

The AGR of plant height in cm per day was maximum due to sugarcane trash mulch amongst different mulch treatments during the period 31 to 60 days growth. However in latter period from 61 to 90 days, it was slightly more due to bitumen mulch than other two mulch treatments. During the 31 to 60 days period, bitumen and no mulch treatments did not show marked difference in AGR. Similar was the case in latter period of 61 to 90 days in case of sugarcane trash and no mulch treatments.

3.1.2 Relative Growth Rate in plant height (RGR) :

The data on RGR of plant height as influenced due to different treatments during two different periods of observations are presented in Table 23.

Table 23 : Mean RGR of plant height (cm) per day during various growth periods as affected by various treatments.

Treatments	Days from sowing	
	31 to 60	61 to 90
<u>Varieties</u> :		
CSH-8R	0.044	0.014
No. 168	0.046	0.016
<u>Irrigations</u> :		
0.50 IW/CPE	0.043	0.015
0.75 IW/CPE	0.047	0.015
<u>Mulches</u> :		
Sugarcane trash	0.048	0.014
Bitumen	0.044	0.016
No mulch	0.044	0.015
General mean	0.045	0.015

The data in Table 23 revealed that the mean RGR of plant height of <u>jowar</u> during 31 to 60 days and 61 to 90 days growth periods was 0.045 and 0.015 cm per day respectively.

<u>Varieties</u> :

Variety No. 168 showed comparatively more RGR in cm per day than hybrid CSH-8R during both the periods of growth under study.

<u>Irrigations</u> :

Irrigations applied at 0.75 IW/CPE enhanced RGR in cm per day during 31 to 60 days growth period than irrigations at 0.50 WUF. However, there was no difference in RGR due to both treatments during the latter period of growth.

Mulches :

Sugarcane trash mulch influenced favourably the RGR of plant height than other two mulch treatments during the period of 31 to 60 days growth. However, such difference in RGR on height was not noticed during the latter period of 61 to 90 days growth.

3.2 Dry matter :

3.2.1 Absolute Growth Rate of dry matter (AGR) :

The data pertaining to the AGR of dry matter (g) per day per plant as influenced during two different periods of observation by different treatments are presented in Table 24.

Table 24 : Mean AGR of dry matter (g) per day per plant during various growth periods as affected by various treatments.

Treatments	Days from sowing	
	31 to 60	61 to 90
Varieties :		
CSH-8R	1.89	1.20
No. 168	1.84	1.12
Irrigations :		
0.50 WUF	1.76	1.13
0.75 WUF	1.98	1.16
Mulches :		
Sugarcane trash	2.04	1.13
Bitumen	1.80	1.15
No mulch	1.81	1.13
General mean	1.88	1.14

The data in Table 24 showed that the mean AGR of dry matter per day per plant during two periods under study was 1.88 and 1.14 g respectively.

Varieties :

The AGR of dry matter was more of hybrid CCH-8R than variety No. 168 during both the periods under study.

Irrigations .

Irrigation application at 0.75 WUF proved beneficial in increasing the AGR of dry matter during both the periods under study than irrigations at 0.50 WUF.

Mulches :

Sugarcane trash mulch favourably influenced the AGR of dry matter during the growth period of 31 to 60 days, than other two mulch treatments. However, it was more or less same in all the mulch treatments, during 61 to 90 days growth period.

3.2.2 Relative Growth Rate (RGR) :

The data on RGR of dry matter per day per plant as affected by various treatments during two periods under study are presented in Table 25.

The average RGR of dry matter per day per plant was 0.070 and 0.014 g during the periods of 31 to 60 and 61 to 90 days, growth respectively.

Table 25 : Mean RGR of dry matter (g) per day per plant during various growth periods as affected by various treatments.

Treatments	Days from sowing	
	31 to 60	61 to 90
<u>Varieties</u> :		
CSH-8R	0.069	0.015
No. 168	0.071	0.014
<u>Irrigations</u> :		
0.50 WUI	0.068	0.015
0.75 WUI	0.074	0.014
<u>Mulches</u> :		
Sugarcane trash	0.072	0.013
Bitumen	0.069	0.015
No mulch	0.068	0.014
General mean	0.070	0.014

<u>Varieties</u> :

RGR of dry matter per day per plant was more of variety No. 168 during 31 to 60 days growth period than hybrid CSH-8R. However, during latter period of growth of 61 to 90 days, it was higher in case of hybrid CSH-8R than variety No. 168.

<u>Irrigations</u> :

RGR of dry matter per day per plant was more due to irrigations at 0.75 WUI during 31 to 60 days growth period than irrigations at 0.50 WUI. However, during latter period of 61 to 90 days growth, it was slightly more in case of irrigations at 0.50 WUF.

Mulches :

Sugarcane trash mulch increased RGR of dry matter per day per plant during 31 to 60 days growth period than other two mulch treatments. However, during latter period of growth of 61 to 90 days, it was more or less same in case of all the mulch treatments.

3.3.3 Net Assimilation Rate (NAR) :

Data regarding the NAR of dry matter (g/dm^2) per day per plant as influenced by various treatments during two periods under study are presented in Table 26.

Table 26 : Mean NAR of dry matter (g/dm^2) per day per plant as affected during the periods by various treatments.

Treatments	Days from sowing	
	31 to 60	61 to 90
Varieties :		
CSH-8R	0.0971	0.0363
No. 168	0.0999	0.0381
Irrigations :		
0.50 WUF	0.0940	0.0364
0.75 WUF	0.1044	0.0360
Mulches :		
Sugarcane trash	0.1057	0.0347
Bitumen	0.0963	0.0370
No mulch	0.0969	0.0365
General mean	0.0991	0.0363

The data in Table 26 indicated that the average NAR of dry matter per day per plant was 0.0991 and 0.0363 during the period of 31 to 60 and 61 to 90 days growth respectively.

Varieties :

NAR of dry matter per day per plant was slightly more in case of variety No. 168 than hybrid CSH-8R during both the periods under study.

Irrigations :

NAR of dry matter per day per plant was more due to irrigations applied at 0.75 WUF during 31 to 60 days growth period than irrigations at 0.50 WUF. However, during the latter period of 61 to 90 days growth, it was equal to both the irrigation levels.

Mulches :

Sugarcane trash mulch was responsible in increasing the NAR of dry matter per day per plant during 31 to 60 days growth period than other two mulch treatments. However, during latter period of growth of 61 to 90 days, it was slightly less in sugarcane trash mulch. There was practically no difference in NAR of dry matter between bitumen and no mulch treatment during both the growth periods.

4. Post harvest studies :

4.1 Earhead measurement studies :

Data pertaining to mean length and girth of earhead and length and diameter of peduncle at harvest are presented in Table 27.

Table 27 : Mean length (cm) and girth (cm) of earhead and length and diameter (cm) of peduncle at harvest.

Treatments	Length of earhead cm	Girth of earhead cm	Length of peduncle cm	Diameter of peduncle cm
<u>Varieties</u> :				
SH-8[illegible]	20.62	15.99	29.65	0.90
No. 168	16.12	15.03	2[illegible].33	1.01
F test	Sig.	Sig.	Sig.	Sig.
S.E. ±	0.059	0.029	0.204	0.006
C.D. at 5 %	0.188	0.094	0.651	0.020
<u>Irrigations</u> :				
At 0.50 WUE	17.86	15.20	25.73	0.93
At 0.75 WUE	18.68	15.82	28.20	0.98
F test	Sig.	Sig.	Sig.	Sig.
S.E. ±	0.059	0.029	0.204	0.006
C.D. at 5 %	0.188	0.094	0.651	0.020
<u>Mulches</u> :				
Sugarcane trash	19.06	15.86	27.98	0.99
Bitumen	18.11	15.32	26.98	0.95
No mulch	17.95	15.36	26.02	0.93
F test	Sig.	Sig.	Sig.	Sig.
S.E. ±	0.042	0.037	0.176	0.006
C.D. at 5 %	0.122	0.107	0.513	0.017
<u>Interactions</u> :				
V x I F test	NS	Sig.	NS	NS
V x M F test	Sig.	NS	Sig.	NS
I x M F test	NS	NS	NS	NS
V x I x M F test	Sig.	NS	N[illegible]	NS
General mean	18.38	15.52	2[illegible].[illegible]0	0.96

NS = Non-significant. Sig. = Significant.

4.1.1 Length of earhead :

The data in Table 27 showed that the mean length of earhead was 18.38 cm.

Varieties :

The length of earhead of hybrid CSH-8R was significantly more than variety No. 168.

Irrigations :

Irrigations applied at 0.75 WUL produced significantly more length of earhead than due to irrigations applied at 0.50 WUL.

Mulches :

Three mulch treatments showed significantly different influence on mean earhead length. Use of sugarcane trash mulch helped in significantly increasing the earhead length than bitumen and no mulch treatments. Bitumen also produced significantly more earhead length than no mulch treatment.

Interactions :

The interaction effects between varieties and mulch treatments and between varieties, irrigations and mulch treatments were statistically significant. The data of which are presented in Table 28 and 29, respectively.

Data in Table 28 revealed that the length of earhead of hybrid CSH-8R was significantly more than variety No. 168 in all the mulch treatments. In both the varieties under study, sugarcane trash mulch was responsible in producing maximum

Table 28 : Mean length (cm) of earhead as affected by varieties x mulches.

Treatments	ugarcane trash cm	Bitumen cm	No mulch cm
CSH-8R	21.71	20.22	19.95
No. 168	16.41	16.00	15.96

S.E. for the comparison of two varieties at the same mulch treatments. ... 0.108

C.D. 0.330

S.E. for the comparison of two mulch treatments at the same varieties. ... 0.085

C.D. 0.248

Table 29 : Mean length (cm) of earhead as affected by varieties x irrigations x mulches.

Treatments	CSH-8R		No. 168	
	0.50 WUF	0.75 WUF	0.50 WUF	0.75 WUF
ugarcane trash	21.25	22.17	16.20	16.62
Bitumen	20.00	20.45	15.62	16.33
No mulch	19.70	20.20	15.65	16.27

S.E. for the comparison of two varieties at the same mulch treatments. ... 0.108

C.D. 0.330

S.E. for the comparison of two mulch treatments at the same varieties /irrigation levels. ... 0.085

C.D. 0.248

and significantly more earhead length than bitumen mulch and no mulch treatments which were on par.

The mean earhead length, in all mulch treatments, was maximum and significantly more of hybrid CSH-8R irrigated with 0.75 WUF (Table 29). The same was followed by same hybrid with 0.50 WUF. In case of variety No. 168, also, under different mulch treatments, application of irrigations at 0.75 WUF was responsible in producing significantly more earhead length than irrigation at 0.50 WUF. Sugarcane trash mulch significantly increased the earhead length in all the combinations of varieties and irrigations than other two mulch treatments which were on par and almost all combinations except the combination of CSH-8R and irrigations at 0.50 WUF, wherein bitumen increased earhead length than control. Hybrid CSH-8R irrigated with 0.75 WUF and with sugarcane trash mulch produced maximum and significantly more earhead length than all the rest of the combinations.

4.1.2 Girth of earhead :

Data in Table 27 showed that there was 15.52 cm mean girth of earhead.

Varieties :

Girth of earhead of hybrid CSH-8R was significantly more than that of variety No. 168.

Irrigations :

Irrigations at 0.75 WUF increased the girth of earhead significantly than due to irrigations at 0.50 WUF.

Mulches :

Sugarcane trash mulch caused increase in girth of earhead significantly than other two mulch treatments which were on par.

Interactions :

Girth of earhead was influenced significantly due to varieties and irrigation treatments combinations. The data of the same are presented in Table 30.

Table 30 : Mean girth (cm) of earhead as affected by varieties x irrigations.

Treatments	0.50 WUF	0.75 WUF
CSH-8R	15.83	16.16
No. 168	14.58	15.48
S.E. ±	0.029	
C.D.	0.094	

The data in Table 30 indicated that the girth of earhead was maximum and significantly higher due to hybrid CSH-8R when applied with irrigations at 0.75 WUF than rest of the combinations. It was followed by the same hybrid with less frequency of irrigations. In variety No. 168 also similar trend was noticed.

4.1.3 Length of peduncle :

The mean length of peduncle was 27.00 cm as revealed from the data in Table 27.

Varieties :

The length of peduncle of hybrid CSH-8R was significantly more than peduncle length of variety No. 168.

Irrigations :

More frequent irrigations applied with 0.75 WUF increased the mean peduncle length than less number of irrigations at 0.50 WUF.

Mulches :

Sugarcane trash mulch was responsible in increasing the average peduncle length than other two mulch treatments which were on par.

Interactions :

The interaction effects of the combination of varieties and mulch treatments were found statistically significant. The data of the same are given in Table 31.

Table 31 : Mean length (cm.) of peduncle as affected by varieties x mulches.

Treatments	Sugarcane-trash	Bitumen	No mulch
CSH-8R	31.12	29.75	28.10
No. 168	24.85	24.21	23.95

S.E. for the comparison of two varieties at the same mulch treatments. ... 0.407

C.D. 1.242

S.E. for the comparison of two mulch treatments at the same varieties 0.352

C.D. 1.028

The data in Table 31 evidenced that in all the mulch treatments, hybrid CSH-8R produced more peduncle length than variety No. 168. In both the varieties under study, sugarcane trash mulch caused significant increase in mean peduncle length than other two mulch treatments which were on par in variety No. 168 while in hybrid CSH-8R bitumen produced significantly more peduncle length than control.

4.1.4 Diameter of peduncle :

On an average, 0.96 cm diameter of peduncle was observed.

Varieties :

The data in Table 27 revealed that the mean diameter of peduncle was significantly more in case of variety No. 168 than that of hybrid CSH-8R.

Irrigations :

Irrigations applied at 0.75 WUF increased significantly the diameter of peduncle than irrigations due to 0.50 WUF.

Mulches :

Sugarcane trash mulch caused significant increase of peduncle diameter than other two mulch treatments. Peduncle diameter was increased significantly by bitumen mulch than no mulch.

Interactions :

None of the interaction effects on peduncle diameter was observed.

4.2 Earhead weight studies :

Data regarding mean weight of earhead, weight of grains per earhead, weight of bhoosa per earhead, number of grains per earhead and thousand grain weight as influenced by different treatments at harvest are presented in Table 32.

4.2.1 Weight of earhead :

The data presented in Table 32 revealed that the mean weight of earhead was 46.96 g.

Varieties :

Weight of earhead of hybrid CSH-8R was significantly more than that of variety No. 168.

Irrigations :

Weight of earhead due to the irrigations at 0.75 WUF was significantly more than due to irrigations at 0.50 WUF.

Mulches :

Sugarcane trash mulch increased significantly the earhead weight than other two mulch treatments, which were on par.

Interactions :

The mean weight of earhead was significantly influehced by the different combinations of varieties and irrigations, varieties and mulch treatments and irrigation and mulch treatments. The data of the same are presented in Table 33.

Table 32 : Mean weight of earhead, weight of grains per earhead weight of <u>bhoosa</u> per earhead, number of grains per earhead and thousand grain weight (g) as affected by various treatments.

Treatments	Weight of earhead (g)	Weight of grains/ earhead (g)	Weight of <u>bhoosa/</u> earhead (g)	Number of grains/ earhead	Thousand grains weight (g)
<u>Varieties</u> :					
CSF-8R	50.52	42.76	7.67	1443.99	32.15
No. 168	43.50	34.80	8.85	1536.78	24.42
F test	Sig.	Sig.	Sig.	Sig.	Sig.
S.E. ±	0.151	0.082	0.152	3.643	0.022
C.D. at 5	0.484	0.263	0.485	11.650	0.071
<u>Irrigations</u> :					
At 0.50 WUE	45.81	37.99	7.98	1486.12	28.68
At 0.75 WUE	48.10	39.58	8.54	1500.66	28.89
F test	Sig.	Sig.	Sig.	Sig.	Sig.
S.E. ±	0.151	0.082	0.152	3.643	0.022
C.D. at 5 %	0.484	0.263	0.585	11.650	0.071
<u>Mulches</u> :					
Sugarcane trash	49.40	40.86	8.58	1511.18	28.86
Bitumen	45.87	37.86	8.09	1484.25	28.00
No mulch	45.60	37.63	8.12	1475.75	27.99
F test	Sig.	Sig.	Sig.	Sig.	Sig.
S.E. ±	0.101	0.101	0.133	3.497	0.026
C.D. at 5 %	0.294	0.294	0.388	10.204	0.075
<u>Interactions</u> :					
VxI F test	Sig.	Sig.	NS	NS	Sig.
VxM F test	Sig.	Sig.	NS	NS	Sig.
IxM F test	Sig.	Sig.	NS	NS	Sig.
VxIxM F test	NS	NS	NS	NS	NS
General mean	46.96	38.79	8.26	1490.40	28.29

NS = Non-significant. Sig. = Significant.

Table 33 : Mean weight (g) of earhead as affected by various interactions.

(a) Varieties x Irrigations :

Varieties	Irrigation treatments		S.E.±	C.D. at 5 %
	0.50 W.U.E.	0.75 W.U.E.		
CSH-8R	49.76	51.08	0.151	0.484
No. 168	41.87	45.13		

(b) Varieties x Mulches :

Varieties	Mulches			*		+	
	Sugarcane trash	Bitumen	No Mulch	S.E. ±	C.D. at 5 %	S.E. ±	C.D. at 5 %
CSH-8R	53.43	49.07	48.74	0.269	0.831	0.201	0.587
No. 168	45.38	42.67	42.45				

(c) Irrigations x Mulches :

Irrigations	Mulches			*		+	
	Sugarcane trash	Bitumen	No Mulch	S.E. ±	C.D. at 5 %	S.E. ±	C.D. at 5 %
0.50 W.U.E.	48.73	44.95	44.77	0.269	0.831	0.201	0.587
0.75 W.U.E.	51.05	46.80	46.49				

Note : * For the comparison of two varieties/irrigation treatments at the same mulch treatment.

+ For the comparison of two mulch treatments at the same variety/irrigation treatment.

The data in Table 33(a) revealed that hybrid CSH-8R with irrigations at 0.75 WUF produced significantly more earhead weight than rest of the combinations. This was followed by the same variety with irrigations at 0.50 WUF. Similar trend was observed in case of the variety No. 168.

The data on combined effect of varieties and different mulches in Table 33(b) indicated that hybrid CSH-8R produced significantly more earhead weight than variety No. 168 in all mulch treatments. Sugarcane trash mulch increased the mean earhead weight of both the varieties than other two mulch treatments, which were on par. Application of sugarcane trash mulch in hybrid CSH-8R produced maximum and significantly more earhead weight than rest of the combinations.

Data in Table 33(c) indicated that with all mulch treatments, irrigations at 0.75 WUF proved beneficial in increasing the earhead weight than irrigations at 0.50 WUF. Sugarcane trash mulch increased the earhead weight significantly than other two mulch treatments, which were on par at both the levels of irrigation. The combination of sugarcane trash mulch and irrigations at 0.75 WUF produced maximum and significantly more earhead weight than rest of the combinations.

The interactions effects between all the three factors under study were not statistically significant.

4.2.2 <u>Weight of grains per earhead</u> :

The mean weight of grains per earhead was 38.79 g as is noticed from the data in Table 32.

Varieties :

Hybrid CSH-8R produced significantly more weight of earhead grains than variety No. 168.

Irrigations :

More frequent irrigations at 0.75 WUF proved helpful as it increased significantly the weight of earhead grains than less frequent irrigations at 0.50 WUF.

Mulches :

Sugarcane trash mulch helped in increasing significantly the weight of grains per earhead than other two mulch treatments, which were on par.

Interactions :

The significant interactions effects were noticed due to the combinations of varieties and irrigations, varieties and mulches and irrigations and mulches. The data regarding the same are presented in Table 34.

The data in Table 34(a) showed that hybrid CSH-8R when irrigated at 0.75 WUF produced significantly more weight of grains per earhead than rest of the combinations. It was followed by the same hybrid with irrigations at 0.50 WUF. Similar trend was also noticed in variety No. 168. All the four combinations differred significantly from each other in their effects on mean weight of grains per earhead.

Data in Table 34 (b) evidenced that in all the three mulch treatments, hybrid CSH-8R produced significantly more

Table 34 : Mean weight (g) of grains per earhead as affected by various interactions.

(a) Varieties x Irrigations

Varieties	Irrigations		S.E. ±	C.D. at 5 %
	0.50 IWUF	0.75 IWUF		
CSH-8R	42.27	43.26	0.082	0.263
No. 168	31.71	35.90		

(b) Varieties x Mulches :

Varieties	Mulches			*		+	
	Sugarcane trash	Bitumen	No mulch	S.E. ±	C.D. at 5 %	S.E. ±	C.D. at 5 %
CSH-8R	45.30	41.58	41.41	0.202	0.606	0.219	0.639
No. 168	36.42	34.14	33.86				

(c) Irrigations x Mulches :

Irrigations	Mulches			*		+	
	Sugarcane trash	Bitumen	No mulch	S.E. ±	C.D. at 5 %	S.E. ±	C.D. at 5 %
0.50 IWUF	39.62	37.28	37.06	0.202	0.606	0.219	0.639
0.75 IWUF	42.10	38.44	38.21				

Note : * For the comparison of two varieties/irrigation treatments at the same mulch treatment.

+ For the comparison of two mulch treatments at the same variety/irrigation treatment.

weight of grains per earhead than variety No. 168. In case of both the varieties, sugarcane trash increased significantly the weight of grains per earhead than other two mulch treatments. The latter two showed statistically same effects. A combination of hybrid CSH-8R with sugarcane trash mulch showed maximum and significantly more mean weight of grains per earhead than rest of the combinations.

Data in Table 34(c) showed that irrigations at 0.75 WUF increased the mean weight of grains per earhead significantly than irrigations at 0.50 WUF in all the mulch treatments. Sugarcane trash mulch increased the grain weight per earhead than other two mulch treatments in both irrigation levels. The latter two mulch treatments were on par. The combination of sugarcane trash and irrigation at 0.75 WUF produced maximum weight of grains per earhead.

4.2.3 Weight of *bhoosa* per earhead :

The data presented in Table 32 showed that during summer the mean weight of *bhoosa* per earhead was 8.26 g.

Varieties :

Hybrid CSH-8R showed significantly more weight of *bhoosa* per earhead than variety No. 168.

Irrigation :

Irrigations at 0.75 WUF increased significantly the weight of *bhoosa* per earhead than the irrigations at 0.50 WUF.

Mulches :

Sugarcane trash mulch increased significantly the mean weight of bhoosa per earhead than other two mulch treatments, which were on par.

Interactions :

None of the interactions effect was statistically significant.

4.2.4 Number of grains per earhead :

The average number of grains per earhead observed was 1490.40 (Table 32).

Varieties :

The number of grains per earhead was significantly more of variety No. 168 than hybrid CSH-8R.

Irrigations :

More frequent irrigations (0.75 WUF) influenced significantly the number of grains per earhead than less frequent irrigations (0.50 WUF).

Mulches :

Sugarcane trash was responsible for increasing the number of grains per earhead significantly over the other two mulch treatments, which resulted in producing statistically equal number of grains.

Interactions :

None of the interactions was found statistically significant.

4.2.5 Thousand grain weight :

The mean thousand grain weight observed was 28.29 g (Table 32).

Varieties :

The thousand grain weight of hybrid CSH-8R was significantly more than variety No. 168.

Irrigations :

The thousand grain weight was significantly more due to more frequent irrigations at 0.75 WUF than the irrigations at 0.50 WUF.

Mulches :

Use of sugarcane trash as mulch was responsible for increasing thousand grain weight significantly over remaining two mulch treatments, which were statistically on par.

Interactions :

The interactions effects due to combinations of varieties and irrigations, varieties and mulches and irrigations and mulches were found significant. The data pertaining to which are presented in Table 35.

The data in Table 35(a) revealed that hybrid CSH-8R when irrigated at 0.75 WUF produced significantly maximum thousand grain weight than rest of the combinations. It was followed by the same hybrid with irrigations at 0.50 WUF. Similar trend was also observed in variety No. 168. All the combinations differred significantly from each other.

Table 35 : Mean thousand grain weight (g) as affected by various interactions.

(a) Varieties x Irrigations :

Varieties	Irrigations		S.E. ±	C.D. at 5 %
	0.50 WUF	0.75 WUF		
CSH-8R	31.77	32.53	0.022	0.071
No. 168	23.59	25.25		

(b) Varieties x Mulches :

Varieties	Mulches			S.E. ± *	C.D. at 5 % *	S.E. ± +	C.D. at 5 % +
	Sugarcane trash	Bitumen	No mulch				
CSH-8R	32.64	31.92	31.90	0.053	0.158	0.052	0.153
No. 168	25.09	24.09	24.09				

(c) Irrigations x Mulches :

Irrigations	Mulches			S.E. ± *	C.D. at 5 % *	S.E. ± +	C.D. at 5 % +
	Sugarcane trash	Bitumen	No mulch				
0.50 WUF	28.04	27.52	27.49	0.053	0.158	0.052	0.153
0.75 WUF	29.69	28.49	28.50				

Note : * For the comparison of two varieties/irrigation treatments at the same mulch treatment.

+ For the comparison of two mulch treatments at the same variety/irrigation treatment.

Data in Table 35(b) indicated that hybrid CSH-8R produced significantly higher thousand grain weight than variety No. 168 with all mulch treatments. Use of sugarcane trash as mulch in hybrid CSH-8R produced maximum thousand grain weight than rest of the combinations. The bitumen mulch did not show significant increase in thousand grain weight over no mulch treatment in case of both the varieties.

Data in Table 35(c) showed that more frequent irrigations (0.75 WUF) produced significantly higher thousand grain weight than less frequent irrigations at 0.50 WUF with all mulch treatments. Use of sugarcane trash mulch with more frequent irrigations at 0.75 WUF produced highest and significantly more thousand grain weight than rest of the combinations. Other two mulches were statistically on par.

5. <u>Yield</u> :

Data pertaining to grain and <u>kadbi</u> yield and grain to <u>kadbi</u> ratio as influenced by different treatments are presented in Table 36 and graphically depicted in Fig. 6 .

5.1 <u>Grain yield</u> :

The data in Table 36 revealed that on an average 48.50 q/ha of <u>jowar</u> grains were harvested during summer 1977.

<u>Varieties</u> :

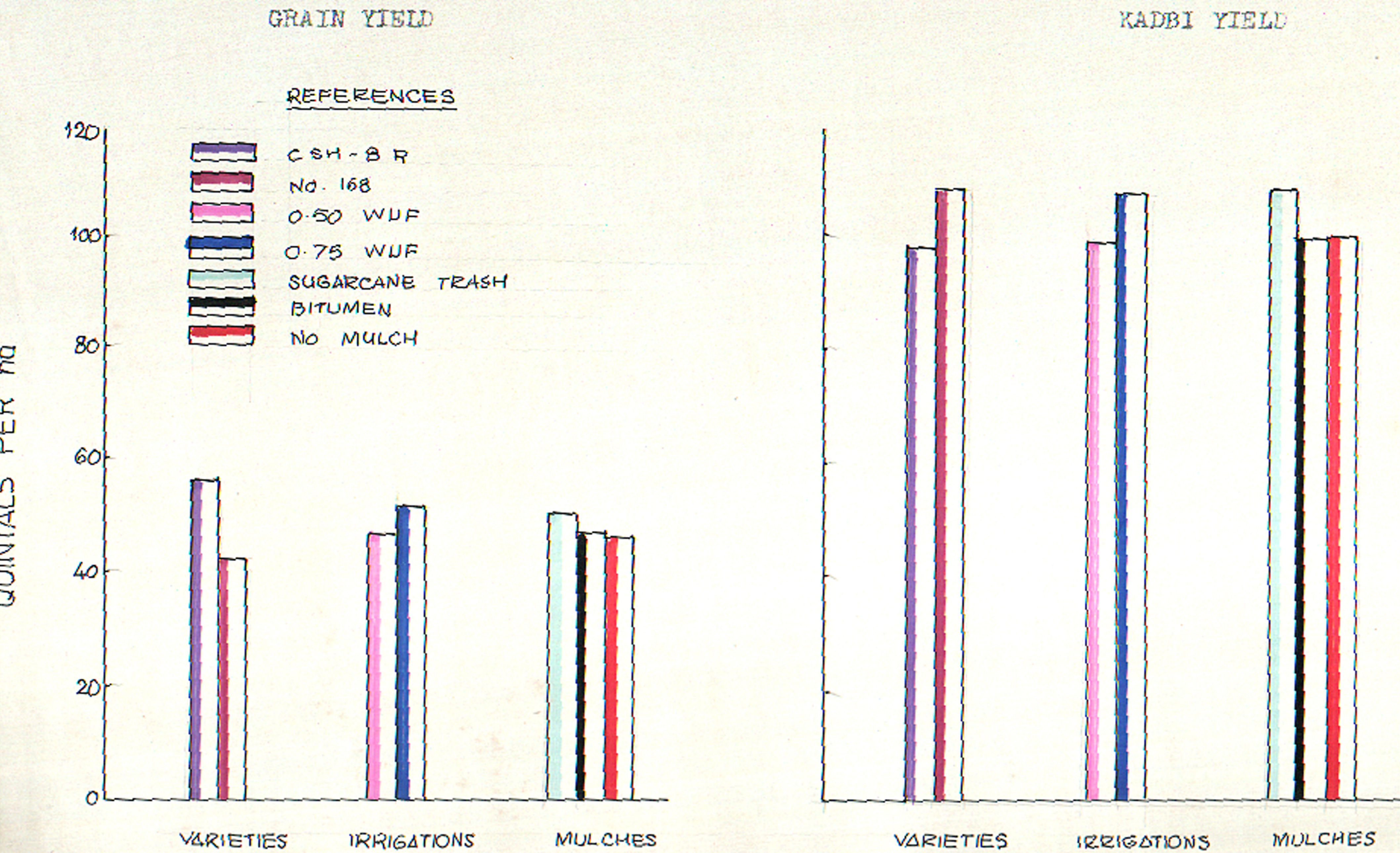
The two varieties under study produced significantly different grain yields. Hybrid CSH-8R produced significantly more grain yield than variety No. 168.

Table 36 : Yields of grain (q/ha) and *kadbi* (q/ha) as affected by various treatments.

Treatments	Grain	*Kadbi*	Grain:*Kadbi*
Varieties :			
CSH-8R	55.47	98.24	1.77
No. 168	41.43	107.94	2.60
F test	Sig.	Sig.	-
S.E. ±	0.275	0.635	-
C.D. at 5 %	0.830	2.046	-
Irrigations :			
At 0.50 [illegible]	46.11	99.38	2.16
At 0.75 [illegible]	50.88	106.79	2.10
F test	Sig.	Sig.	-
S.E. ±	0.275	0.635	-
C.D. at 5 %	0.830	2.046	-
Mulches :			
Sugarcane trash	51.42	108.38	2.11
Bitumen	47.21	100.09	2.12
No mulch	46.73	100.79	2.15
F test	Sig.	Sig.	-
S.E. ±	0.256	0.582	-
C.D. at 5 %	0.748	1.693	-
Interactions :			
V x I — F test	Sig.	NS	-
V x M — F test	Sig.	NS	-
I x M — F test	Sig.	Sig.	-
V x I x M — F test	NS	NS	-
General mean	48.50	103.75	2.14

NS = Non-significant. Sig. = Significant.

FIG.6 MEAN YIELD OF GRAIN AND KADBI (q/ha) AS AFFECTED BY VARIOUS TREATMENTS



Irrigations :

More number of irrigations applied at 0.75 WUF were responsible for increasing the grain yield significantly than with the less number of irrigations at 0.50 WUF.

Mulches :

Use of sugarcane trash mulch significantly increased *jowar* grain yields than the bitumen mulch treatment and no mulch treatment. The latter two produced statistically equal yields. Bitumen mulch did not help in increasing *jowar* grain yields.

Interactions :

Jowar grain yields were also influenced significantly due to interactions effects of varieties and irrigations, varieties and mulch treatments and irrigations and mulch treatments. The data regarding which are presented in Table 37.

A glance at the data in Table 37(a) indicated that in case of both the varieties, more number of irrigations at 0.75 WUF produced significantly more yield of grains than irrigations at 0.50 WUF. In case of both irrigation treatments, hybrid CSH-8R significantly out yielded variety No. 168. The hybrid CSH-8 irrigated with 0.75 WUF yielded maximum and significantly more than other three combinations. It was followed by the same hybrid with comparatively less number of irrigations (0.50 WUF).

The data in Table 37 (b) showed that in case of both

Table 37 : Mean grain yield (q/ha) as affected by various interactions.

(a) Varieties x Irrigations :

Varieties	Irrigations		S.E.±	C.D. at 5 %
	0.50 WUF	0.75 WUF		
CSH-8R	54.50	56.44	0.275	0.880
No.168	37.65	45.32		

(b) Varieties x Mulches :

Varieties	Mulches			*		+	
	Sugarcane trash	Bitumen	No mulch	SE ±	CD at 5 %	SE ±	CD at 5 %
CSH-8R	59.35	53.76	53.31	0.573	1.832	0.511	1.491
No. 168	43.49	40.65	40.26				

(c) Irrigation x Mulches :

Irrigation	Mulches			*		+	
	Sugarcane trash	Bitumen	No mulch	SE ±	CD at 5 %	SE ±	CD at 5 %
0.50 WUF	48.30	45.08	44.81	0.573	1.832	0.511	1.491
0.75 WUF	54.53	49.33	48.75				

Note : * For the comparison of two varieties/irrigation treatments at the same mulch treatment.

\+ For the comparison of two mulch treatments at the same variety/irrigation treatment.

the varieties under study, sugarcane trash mulch produced significantly more grain yield than other two mulch treatments, which were on par. In all the mulch treatments, hybrid CSH-8R significantly out yielded the variety No. 168. Hybrid CSH-8R with sugarcane trash mulch produced maximum and significantly more grain yield than rest of the combinations. It was followed by the same hybrid with other two mulch treatments which were on par.

The data in Table 35(c) evidenced that with both irrigation levels, application of sugarcane trash mulch was significantly beneficial than other two mulch treatments. The latter two mulch treatments produced statistically similar yields in case of both irrigation levels. Higher frequency of irrigations proved significantly superior in respect of grain yield than lower frequency of irrigation. In all the three mulch treatments, sugarcane trash mulch with irrigations at 0.75 WUF produced maximum and significantly more grain yield than rest of the combinations. The next best in order were the two combinations of two mulch treatments with irrigations at 0.75 WUF, which were on par.

5.2 Kadbi yield :

The data regarding kadbi yield presented in Table 36 revealed that on an average 103.75 q/ha of kadbi were harvested per hectare.

Varieties :

Kadbi yield of the variety No. 168 was significantly more than that of the kadbi yield of hybrid CSH-8R as is seen from the data in Table 36.

Irrigations :

More number of irrigations given at 0.75 WUF caused significant increase in kadbi yield than due to the irrigations at 0.50 WUF.

Mulches :

Application of sugarcane trash mulch proved beneficial as it increased significantly the kadbi yield than other two mulch treatments. Use of bitumen as mulch did not increase the kadbi yield over control.

Interactions :

The kadbi yield was influenced significantly by the combined effects of irrigation levels and mulch treatments, the data of which are presented in Table 38. The other interactions effects were not statistically significant.

Table 38 : Mean kadbi yield (q/ha) as affected by irrigation mulches.

Treatments	Sugarcane-trash	Bitumen	No mulch
0.50 WUF	103.26	97.53	97.53
0.75 WUF	113.49	102.73	104.15

S.E. for the comparison of two irrigation treatments at the same mulch treatments. .. 1.314

C.D. 3.995

S.E. for the comparison of two mulch treatments at the same irrigation treatments ... 1.173

C.D. 3.430

The data in Table 38 showed that the use of sugarcane trash as mulch proved significantly useful in increasing kadbi yields than other two mulch treatments with both the levels of irrigations. Bitumen mulch and no mulch treatments did not differ significantly in case of both the irrigation levels. Irrigation application at 0.75 WUF caused significant increase in all the three mulch treatments over irrigations at 0.50 WUF. Use of sugarcane trash mulch and irrigations at 0.75 WUF produced maximum and significantly more kadbi yield than rest of the combinations.

5.3 Grain to kadbi ratio :

The data in Table 36 indicated that the ratio of grain to kadbi was 2.14 during summer.

Varieties :

Grain to kadbi ratio was wider in case of variety No. 168 as compared to hybrid CSH-8R.

Irrigations :

Irrigation treatments did not show marked influence on grain to kadbi ratio of jowar. However, it was slightly wider with less number of irrigations at 0.50 WUF than more frequent irrigations at 0.75 WUF.

Mulches :

In case of no mulch treatment, grain to kadbi ratio was wider which was followed by bitumen mulch and sugarcane trash mulch.

6. Chemical studies :

With a view to assess the total nitrogen uptake by jowar varieties with and without mulch, under varying levels of irrigation, the chemical studies in respect of percentage nitrogen in different plant parts, including grain was determined at harvest. The details of which are as under.

The data regarding nitrogen concentration in different plant parts and uptake of nitrogen per plant and its parts and total nitrogen uptake per hectare at harvest as influenced by different treatments are presented in Table 39.

6.1 Percentage nitrogen in different plant parts :

The data in Table 39 revealed that on an average jowar grain contained 1.39 per cent nitrogen. The mean percentage of nitrogen in stem and leaves during summer was 0.44 and 0.74, respectively.

Varieties :

The percentage concentration of nitrogen in different plant parts at harvest was more in case of the variety No. 168 than the hybrid CSH-8R.

Irrigations :

The percentage concentration of nitrogen in grains, stem leaves was more in case of less number of irrigations with larger interval than more number of irrigations with shorter interval.

Table 39 : Mean concentration of nitrogen per cent in different plant parts and uptake of nitrogen per plant and per hectare as affected by various treatments.

Treatments	Nitrogen per cent			Uptake of nitrogen(g)/plant				Total uptake of nitrogen (kg/ha)	Protein per cent
	Grain	Stem	Leaves	Grain	Stem	Leaves	Total		
<u>Varieties</u> :									
CSH-8R	1.35	0.43	0.73	0.577	0.145	0.208	0.930	131.14	8.44
No. 168	1.42	0.46	0.75	0.494	0.183	0.260	0.942	132.16	8.88
<u>Irrigations</u>									
0.50 WUF	1.42	0.46	0.75	0.537	0.168	0.229	0.934	130.94	8.88
0.75 WUF	1.36	0.42	0.72	0.530	0.164	0.239	0.939	131.79	8.50
<u>Mulches</u> :									
Sugarcane trash	1.35	0.42	0.71	0.550	0.170	0.236	0.956	134.55	8.44
Bitumen	1.40	0.45	0.76	0.530	0.162	0.234	0.926	130.08	8.75
No mulch	1.41	0.46	0.75	0.530	0.165	0.232	.927	130.22	8.81
General mean	1.39	0.44	0.74	0.536	0.166	0.234	0.936	131.65	8.66

Mulches :

The jowar plant grown without mulch showed higher concentration of nitrogen in different plant parts, studied as compared to bitumen mulch and sugarcane trash mulch. However, the differences were larger in case of sugarcane trash mulch and no mulch treatment as compared to bitumen mulch and no mulch treatment.

6.2 Uptake of nitrogen per plant :

The data regarding the uptake of nitrogen per plant and by different plant parts presented in Table 39 showed that the mean total uptake of nitrogen by the jowar plant under summer conditions was 0.936 g at harvest. Out of which 0.536 g was in grains, 0.166 g in stem and 0.234 g in leaves.

Varieties :

The data regarding uptake of nitrogen by jowar plant and its components at harvest of the two varieties under study revealed that the total uptake of nitrogen per plant was more in case of variety No. 168 than hybrid CSH88R. The similar trend was also evidenced in case of the uptake by stem and leaves of jowar plant. However, the uptake of nitrogen through grain was more in case of hybrid CSH-8R than No. 168.

Irrigations :

The total nitrogen uptake by the jowar plant under summer conditions was also influenced by the irrigation treatments. It was more in case of irrigations with 0.75 WUF than 0.50 WUF. Similar trend was also observed in case of the uptake of nitrogen in leaves. In case of grain and stem the uptake was more due to less number of irrigations at 0.50 WUF.

Mulches :

Sugarcane trash mulch favourably influenced the nitrogen uptake by total plant and also its components than bitumen mulch treatment and no mulch treatment. The latter two showed almost similar effects on nitrogen uptake by the plant and its components.

6.3 Total uptake of nitrogen per hectare :

The data regarding nitrogen uptake per hectare presented in Table 39 revealed that jowar under summer conditions removed on an average 131.65 kg of nitrogen.

Varieties :

There was slight difference in per hectare nitrogen removal of the two varieties. Variety No. 168 removed slightly more nitrogen per hectare than hybrid CSH-8R.

Irrigations :

Nitrogen removed by jowar from one hectare was slightly more in case of irrigations at 0.75 WUF than due to irrigations at 0.50 WUF.

Mulches :

Mulch treatments showed the differential effect on per hectare nitrogen removal by jowar plant. Sugarcane trash mulch increased the nitrogen removal per hectare than in other two treatments. The latter two treatments did not show the difference.

6.4 Crude protein in grains :

Crude protein content in sorghum grains as influenced by various treatments are given in Table 39.

The data in Table 39 indicated the average crude protein content of 8.66 per cent in jowar grains grown under summer conditions.

Varieties :

The data indicated that the crude protein contents in the grains of the variety No. 168 was more than hybrid CSH-8R indicating thereby that the grain of variety No. 168 is of better quality than the grain quality of hybrid CSH-8R.

Irrigations :

The percentage protein content was more from the treatment of irrigation application at 0.50 WUF than irrigations at 0.75 WUF.

Mulches :

The percentage protein content was also influenced by mulch treatments. It was more in control than mulch treatments. Sugarcane trash mulch showed considerably less percentage of protein in grains than bitumen mulch treatment.

7. Soil moisture studies :

The data regarding the cummulative evaporation values, number of irrigations, interval between successive irrigations are presented in Table 40.

Table 40 : Cummulative evaporation values, number of irrigations, interval between successive irrigations and average interval as per irrigation treatments.

Irrigation treatments	Evaporation mm	No. of irrigations	Interval between successive irrigation turns (days)										
			Common irrigations			As per treatments (number)							Av. days
			At sowing	2	3	4	5	6	7	8	9	10	
0.50 WUI	144	8	0	12	21	14	14	16	14	16	-	-	14.5
0.75 WUI	96	10	0	12	21	10	9	10	10	11	9	11	10

It is seen from the Table 40 that in both the irrigation treatments, three irrigations were common. There were five irrigations applied excluding three common irrigations in the treatment where irrigations were applied at 0.50 WUF while seven irrigations applied in addition to three common irrigations in the treatment of 0.75 WUF. The average intervals between two successive irrigations were 14.5 days and 10 days in the treatments of irrigations at 0.50 WUF and 0.75 WUF respectively.

The data regarding the soil moisture percentage are presented in Table 41.

The data from the Table 41 indicated that there was practically no difference in soil moisture percentages after irrigations in all the treatments and both the WUF's. However, the soil moisture percentages before irrigations differred in different treatments.

Varieties :

The soil moisture percentages before irrigation were practically not influenced by hybrid CSH-8R and variety No.168 at both the depths.

Irrigations :

The soil moisture percentages before irrigations were higher in 0.75 WUI treatment as compared to those in 0.50 WUI treatment.

Mulches :

Sugarcane trash used as mulch showed more soil moisture percentage before irrigation than bitumen and no mulch treatment. Bitumen mulch and no mulch treatments, showed practically no difference in soil moisture percentages before irrigations.

There were higher soil moisture percentages in all the mulch treatments with irrigations at 0.75 WUI than those with irrigations at 0.50 WUI.

8. Other studies :

8.1 Weight of weeds :

The data regarding dry weight of weeds removed at harvest from different treatments are presented in Table 52.

Data in Table 42 evidenced that on an average 0.668 kg of weeds were observed per plot (5.89 q/ha) at harvest.

Varieties :

The dry weight of weeds per hectare was not influenced

Table 42 : Mean dry matter (kg) of weeds per plot and per hectare as affected by various treatments at harvest.

Treatments		Dry matter (kg) of weeds	
		Per plot	Per hectare (q)
<u>Varieties</u> :			
CSH-8R		0.660	5.81
No. 168		0.677	5.97
F test		NS	NS
S.E. ±		0.043	0.38
C.D. at 5 %		-	-
<u>Irrigations</u> :			
At 0.50 IUF		0.561	4.95
At 0.75 IUF		0.776	6.84
F test		Sig.	Sig.
S.E. ±		0.043	0.38
C.D. at 5 %		0.137	1.21
<u>Mulches</u> :			
Sugarcane trash		0.506	4.41
Bitumen		0.724	6.40
No mulch		0.779	6.87
F test		Sig.	Sig.
S.E. ±		0.035	0.31
C.D. at 5 %		0.104	0.92
<u>Interactions</u>			
V x I	F test	NS	NS
V x M	F test	NS	NS
I x M	F test	NS	NS
V x I x M	F test	NS	NS
General mean		0.668	5.89

NS = Non-significant.   Sig. = Significant.

significantly by two varieties under study.

Irrigations :

The irrigations given at 0.75 WUF showed significantly more dry weight of weeds per hectare than irrigations at 0.50 WUF.

Mulches :

Application of sugarcane mulch proved beneficial as it reduced the dry weight of weeds significantly at harvest than other two mulch treatments. The bitumen mulch, however, did not supress weed growth as the dry weights of weeds from no mulch and bitumen mulch were on par.

8.2 Soil temperature :

The data on soil temperatures recorded at 10 cm depth in different treatments on 100th day of growth are given in Table 43.

Table 43 : Mean soil temperature at 10 cm depth at 100th day growth as affected by various treatments.

Treatments		Soil temperatures °C
Varieties :	CoH-8R	32.8
	No. 168	32.3
Irrigations :	0.50 WUF	32.6
	0.75 WUF	32.6
Mulches :	Sugarcane trash	31.3
	Bitumen	33.3
	No mulch	33.3
General mean		32.6

The data in Table 43 showed that the mean soil temperature at 10 cm depth in jowar field during summer was 32.06°C.

Varieties :

The varieties had no much effect on soil temperatures at 10 cm soil depth.

Irrigations :

The irrigation treatments also did not show differential influence on soil temperatures recorded on 100th day of growth of jowar.

Mulches :

The mulch treatments showed effect on soil temperature. The application of sugarcane trash as mulch lowered the soil temperature by 2°C during summer than no mulch and bitumen mulch treatment. The bitumen mulch, however, did not show any effect on soil temperature as compared to control.

Chapter V

D I S C U S S I O N

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Chapter V

D I S C U S S I O N

Results of the present investigation, on the comparative performance of two sorghum varieties., CSH-8R and No. 168, with two levels of irrigation (0.50 WUI and 0.75 WUI) and three mulch treatments viz., sugarcane trash, bitumen and control, under summer conditions, reported in preceeding chapter are discussed in this chapter.

Hybrid <u>jowar</u> is gaining importance due to its high yielding and responsive capacity to good irrigation and fertilizer applications. Further, it can be grown in all the three seasons. The irrigation water is a scares and costly and an important commodity specially so during the summer season. Use of mulch has been practiced since long for conserving soil moisture and thereby increasing yields by different crops (Singh and Mederski, 1957; Moody <u>et al</u>., 1963; Tiwari <u>et al</u>., 1970). Mulches have been thus advocated for increasing the water use efficiency by crops since long.

The above considerations necessited the present investigation to find out the yielding ability of the two varieties during summer and the consumptive use and moisture use efficiency by these varieties with and without mulches, under summer conditions, at Rahuri.

<u>Soil, weather and crop development</u> :

The soil analysis of the experimental field at the commencement of the season indicated that the soil used for the investigation was clayey in texture and medium in total nitrogen and available P_2O_5 and high in available K_2O. It was slightly alkaline in reaction, well drained, medium black in colour and medium in depth.

During entire growth period, the mean maximum and mean minimum temperatures ranged from 29.8 to 39.2°C and 15.2 to 24.2°C respectively. The mean humidity percentage ranged from 45 to 89 per cent. The crop was sown on 26th February, 1977 with presoaking irrigation. The germination of crop was satisfactory and required plant number was maintained by the operations like gap filling and thinning. The slight incidence of shoot fly (Atherigona indica) at first thinning and moderate incidence of stem borer (Chillo zorellus was observed despite the corbofuron seed treatment. These pests were controlled by spraying of 20 E.C. endrin. To avoid the probable incidence of midgefly (Contarinia sorghicola, Coq) and army worm (Cirphis unipunta), 10 per cent B.H.C. was dusted at 50 per flowering stage.

With a view to have a general idea about the nature of growth and development of crop under summer conditions, an extract of relevant information on important growth and yield characters, grain and kadbi yields, and uptake of nitrogen at harvest is presented in Table 44 and 45.

The growth and development of crop, measured in terms of plant height, leaf number per plant, leaf area and dry matter, evidenced that crop showed increased growth with the advancement in the age of the crop.

It is evident from the data in Table 44 that <u>jowar</u> plant showed increase in height upto harvest and upto 60th day, in respect of functional leaf number. Upto 60th day, there was rapid growth in terms of height as compared to 60 to 90 days growth period. Functional leaf number was reduced after 60 days and was 8.05 per plant at harvest as against maximum number of 11.82 per plant on 60th day. This indicated that the hybrid and high yielding varieties do not drop off 68.10 per cent of the leaves till harvest during summer. Out of 31.90 per cent leaf drop from 60 days till harvest, 23.77 per cent i.e. about 74.00 per cent of the total drop was noticed during 60 to 90 days growth period.

It was noticed that mean leaf area per plant was maximum of 34.33 dm^2 at 60 days growth and it was reduced to 29.21 dm^2 and 23.32 dm^2 at 90 days and at harvest respectively. This reduction in leaf area might have been because of the reduction in leaf number.

Mean dry weight per plant was increased with the advancement in the age of the crop. This increase was rapid during 30 to 60 days growth period and the rate of increase was slowed down thereafter. At 60 days and at harvest, the mean total dry weight per plant was 64.31 g and 115.94 g respectively. The data regarding the contribution by different plant parts to total dry weight per plant given in Table 18 indicated that there was increase of 3.42 g per plant in vegetative parts as against an increase of 31.02 g per plant in reproductive part, from 60 to 90 days growth. However, the dry matter production by stem and leaves and that of reproductive parts, during the period from 90 days till harvest was almost same. This indicated that the increase in dry matter per plant was more due to vegetative parts upto 60 days growth and due to reproductive part from 60 to 90 days growth. There was almost equal increase due to vegetative and reproductive parts after 90 days growth. At 60 days growth, the contribution by leaves was slightly more than that of stem in total dry matter contribution by vegetative parts. At 90th day, the reverse was the trend in dry matter contribution of vegetative parts. This might be because of the leaf drop of 31.90 per cent and more dry matter accumulation in stem. The data on AGR and RGR of plant height further strengthened the indications that there was maximum growth in terms of height, during 30 to 60 days growth as compared to 60 to 90 days growth. The mean AGR, RGR and NAR value of dry matter also evidenced the similar trend of growth during different periods of observations.

The data in Table 45 revealed that the mean length of earhead was 18.38 cm and the mean girth of earhead was 15.52 cm with the ratio of 1:0.84 of the length and girth of earhead during summer season. Mean length and mean diameter of peduncle observed was 27.00 cm and 0.96 cm respectively. The mean weight of earhead was 46.96 g. The mean weight of grains and that of <u>bhoosa</u> per earhead was 38.79 g and 8.26 g, respectively. The contribution of grains per earhead weight was 82.44 per cent. The ratio of weight of grain to that of bhoosa per earhead was 0.21. The mean number of grains per earhead was 1490.40 and the mean thousand grain weight was 28.29 g. The mean grain yield and kadbi yield per hectare, during summer was 48.50 q and 103.75 q, respectively. The mean grain to kadbi ratio during summer was 2.14

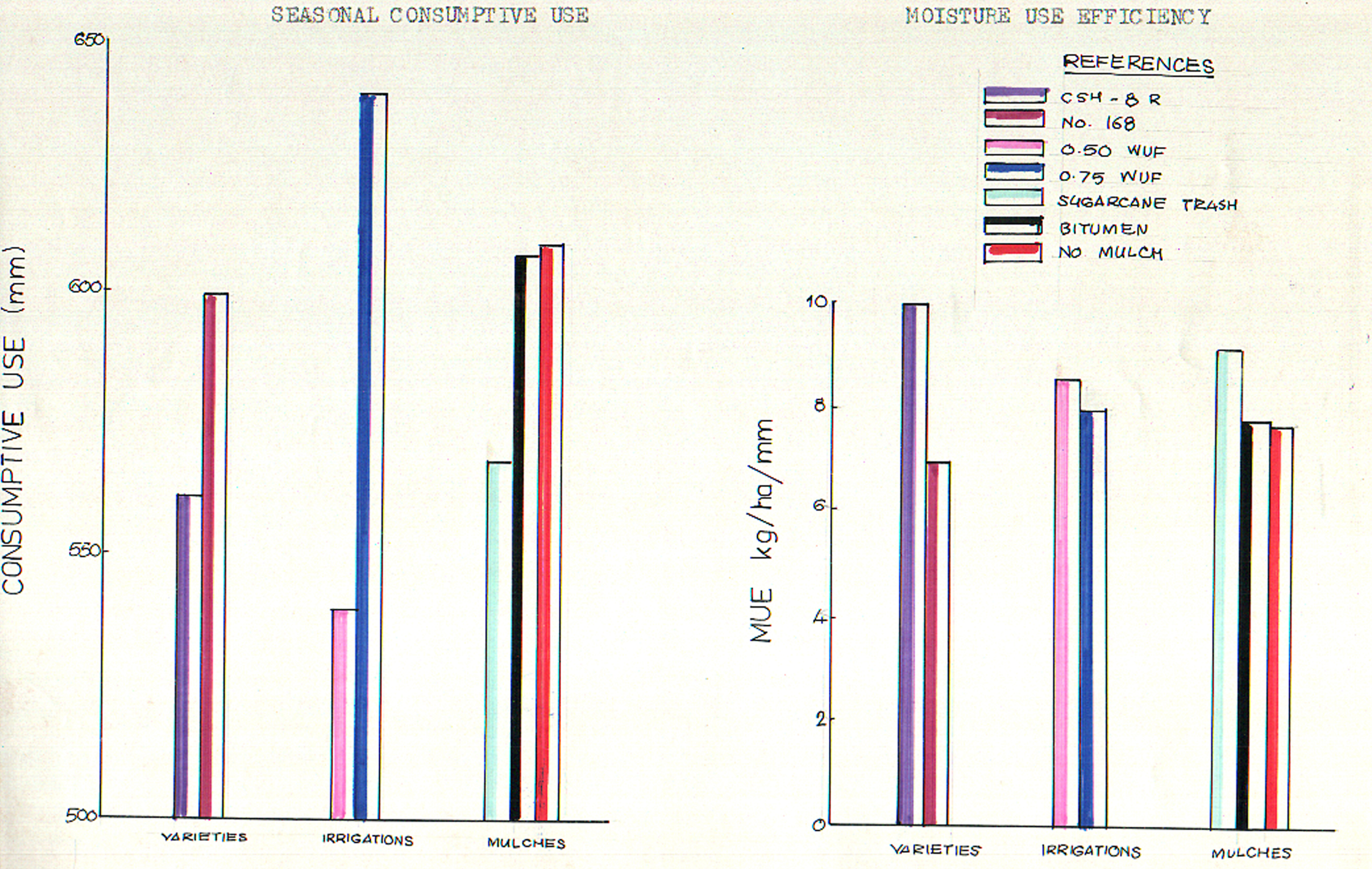
The studies on percentage concentration of nitrogen in different plant parts indicated that jowar grains contained 1.39 per cent of nitrogen as against 0.74 per cent in leaves and 0.44 per cent in stem. The total nitrogen removed by jowar plant was 0.936 g. Out of this 57.26 per cent of nitrogen was accumulated in grains, 25.01 per cent in leaves and 17.73 per cent in stem. During summer, jowar had removed 131.65 kg of nitrogen per hectare. The crude protein studies showed 8.66 per cent crude protein in jowar grains.

The data regarding the mean seasonal and per day consumptive use (mm) and moisture use efficiency (kg/ha) per mm as influenced by different treatments under study are presented in Table 46 and graphically shown in Fig. 7.

Table 46 : Mean seasonal and per day consumptive use (mm) and moisture use efficiency (kg/ha/mm of water) as influenced by various treatments.

Treatments		Consumptive use		Moisture use efficiency (kg/ha/mm)
		Seasonal (mm)	Per day (mm)	
Varieties :	CSH-8R	561.1	4.8	9.89
	No. 168	599.7	4.7	6.92
Irrigations:	0.50 [illegible]	539.0	4.2	8.54
	0.75 [illegible]	639.5	5.0	7.96
Mulches :	Sugarcane trash	568.1	4.5	9.05
	Bitumen	608.0	4.8	7.76
	No mulch	609.4	4.8	7.68
General mean		58[illegible].3	4.7	8.27

FIG.7 MEAN SEASONAL CONSUMPTIVE USE OF WATER (mm) AND MOISTURE USE EFFICIENCY (kg/ha/mm of water)



It is evidenced from the data in Table 46 that the mean seasonal consumptive use of jowar during summer under the experimental conditions was 588.3 mm. The arithmetic mean of the consumptive use per day was 4.7 mm while the moisture use efficiency was 8.27 (kg/ha) per mm during summer.

The studies on the growth of weeds in jowar field measured in terms of dry weight at harvest, showed that 5.89 q of dry weeds per hectare were removed at harvest despite one weeding done at 28 days growth (Table 42). The mean soil temperature at 10 cm depth, on 100th day of growth of jowar during summer was 32.6°C (Table 43).

Varieties :

The data regarding the growth characters as observed in the two varieties under study during summer conditions presented in Table 44 revealed that on all the days of observations the height of jowar plant was significantly more in case of hybrid CSH-8R than variety No. 168. The mean AGR and RGR of plant height also strengthened the indications as regards the comparative growth of two varieties in terms of height during both the growth periods under study.

The functional leaf number, at early stage on 30th day, was more of hybrid CSH-8R than variety No. 168. However, during the latter period of growth, variety No. 168 produced more number of leaves than hybrid CSH-8R. At harvest also, the variety No. 168 showed more number of leaves per plant. At 60 days growth, when there was maximum foliage, variety No. 168

showed more number of functional leaves than hybrid CSH-8R indicating thereby that the number of functional leaves was more of variety No. 168 than Hybrid CSH-8R.

The studies on leaf area per plant of the two varieties under study, revealed that, it was more in case of hybrid CSH-8R than variety No. 168 upto 90 days growth. However, at harvest, it was more in case of variety No. 168 than hybrid CSH-8R. Looking to the functional leaves and leaf area of the two varieties under study, it can be concluded that the leaf size of variety No. 168 was smaller than the leaf size of hybrid CSH-8R under summer conditions.

It is evidenced from the data on the total dry weight per plant at different stages of growth (Table 44) that the total dry weight was more in case of hybrid CSH-8R than variety No. 168 upto 90 days growth. However, at harvest, the total dry weight per plant was more in case of variety No. 168 than hybrid CSH-8R. This increase in dry weight may be attributed to comparatively more leaf number and leaf area of variety No. 168 than hybrid CSH-8R at harvest. Further the increased duration by eleven days of variety No. 168 might have added to the increased dry weight per plant. In general, it can be concluded that variety No. 168 was accumulated more dry matter after 90 days growth till harvest than hybrid CSH-8R. The mean AGR and RGR of dry matter was maximum in case of hybrid CSH-8R during both the periods of growth under study. However, the NAR of dry matter during both the periods under study was more in case of variety No. 168 than hybrid CSH-8R.

The data regarding yield contributing characters, yield of both grain and kadbi and uptake of nitrogen at harvest presented in Table 45 revealed that mean length of earhead, mean girth of earhead, mean weight of earhead, mean weight of grains per earhead, mean length of peduncle and mean thousand grain weight, were more in case of hybrid CSH-8R than variety No. 168. The mean diameter of peduncle and mean number of grains per earhead were more in case of variety No. 168 as compared to hybrid CSH-8R. Though the length and girth of earhead was more and the number of grains per earhead was less, the weight of grains per earhead was more in case of hybrid CSH-8R than the variety No. 168. This clearly indicated that the size of the grain of hybrid CSH-8R was bigger than the grain size of variety No. 168. This was further strengthened by the fact that the thousand grain weight of hybrid CSH-8R was much more than the thousand grain weight of variety No. 168. Though the mean weight of bhoosa per earhead was more in case of variety No. 168, the mean grain weight per earhead and the total weight per earhead were more of hybrid CSH-8R, which further indicated that the grain size and thousand grain weight attributed more in increasing the earhead weight and total grain yield of hybrid CSH-8R than variety No. 168.

The data on mean grain yield per hectare also clearly brought out that hybrid CSH-8R was superior than variety No.168. The behaviour of hybrid CSH-8R in respect of grain yield was thus in keeping with its behaviour in case of yield attributes. However, the yield of kadbi of variety No. 168 (107.94 q/ha) was more than that of hybrid CSH-8R. Looking to the dry weight produced at different stages of observations and at harvest by both the varieties under study, it could be concluded that hybrid CSH-8R was more efficient in transforming the dry matter accumulation in grains than variety No. 168. The grain to kadbi ratio was wider in case of variety No. 168 than hybrid CSH-8R which might have also attributed to the lesser ability of variety No. 168 in proportionately transforming the assimilated dry matter in the reproductive part than hybrid CSH-8R under summer conditions.

The variety No. 168 showed more percentage concentration of nitrogen in all the parts studied, including grains than hybrid CSH-8R. The uptake studies, revealed that grains of hybrid CSH-8R had accumulated more nitrogen than variety No.168, though the variety No. 168 showed more quantity of nitrogen accumulated in grains, stem, leaves and total plant. This indicated that hybrid CSH-8R has more efficiently transformed nitrogen into economic parts than variety No. 168. In short nitrogen removed by the plant was more utilised for formation and development of grains by hybrid CSH-8R, while for growth of vegetative parts by variety No. 168. Though nitrogen removed by grains per plant was more in case of hybrid CSH-8R, the percentage crude protein content of grains was more in case of variety No. 168. If the yield of grains per hectare and protein contents of the two varieties are considered, the total crude proteins were more of hybrid CSH-8R than variety No. 168. However, only if percentage crude protein contents of grain are considered, variety No. 168 has comparatively quality grain. In total uptake of nitrogen per hectare of the two varieties, there was no much difference.

The studies on the mean seasonal consumptive use and per day consumptive use as was observed in case of two varieties under study clearly indicated that the seasonal consumptive use of variety No. 168 was more (599.7 mm) while per day consumptive use was less (4.7 mm) per day, consumptive use of variety No. 168 was comparatively less because of more number of days required for its maturity. Moisture use efficiency worked out in relation to grain yield clearly showed that variety No. 168 was not as able to convert the water used for grain formation as that of hybrid CSH-8R. The moisture use efficiency was almost 1-and-half times more of hybrid CSH-8R than variety No. 168. However, if the kadbi yields are considered, variety No. 168 produced more kadbi yield than hybrid CSH-8R. In other words, variety No. 168 failed to make use of water for the production of economic produce as compared to hybrid CSH-8R. The similar trend regarding the seasonal consumptive use and moisture use efficiency of a hybrid and a variety studied under *kharif* conditions was observed by Singh and Bains (1971) They have observed the less consumptive use and high moisture use efficiency by hybrid CSH-1 than variety Swarna during *kharif* season.

The total dry weight of weeds (Table 42) removed at harvest, from the fields of two varieties under study did not show difference, indicating thereby that the two varieties had no much differential behaviour with weeds showing different effects of their association on weed growth. In other words, varieties had no differential behaviour in respect of weeds either in supressing or enhancing the weed growth. It was further observed that the two varieties under study had not influenced the soil temperatures differently (Table 43).

Irrigations :

The data pertaining to different growth characters in Table 44 evidenced that the growth characters such as mean plant height, mean number of functional leaves were influenced significantly at 60 days and 90 days of growth and at harvest by irrigation treatments. Frequent irrigations at 0.75 WUI showed more mean height and mean number of functional leaves than irrigations at 0.90 WUI. This difference however, was not visible on 30th day i.e. prior to the effecting of irrigation treatments. The growth measured in terms of leaf area per plant and dry weight per plant also evidenced the similar trend at 60, 90 days of growth and at harvest. Seven irrigations given after 35th day i.e. after application of mulch thus enhanced the growth in terms of leaf area and total dry matter per plant as compared to five irrigations given after application of mulch. Application of 720 mm of water in ten number of irrigations with around 10 days interval, thus was more effective in increasing the growth of jowar under summer conditions as compared to 586 mm of water applied in eight irrigations with an interval of around 14 days. The higher soil moisture regime maintained because of irrigations at 0.75 WUF thus helped in increasing the growth of jowar with in the terms of mean height, mean number of functional leaves, leaf area per plant and total dry weight per plant. The growth of jowar was thus influenced by irrigations in conformity with the observations by Kramer and Ross (1970).

The growth functions studied also indicated more useful effects of frequent irrigations with less interval of irrigation on the growth rate measured in terms of AGR and RGR of plant height and AGR, RGR of dry matter and NAR of dry matter. The values of these growth functions were higher in case of 0.75 WUF during the period of 30-60 days growth while during 60-90 days growth, it was almost the same in case of RGR and NAR of dry matter. In other words irrigation water applied at 0.75 WUF during 30 to 60 days period enhanced the growth rate of height and dry matter accumulation than 0.50 WUF. During 60-90 days period, there was enhancement in the AGR of height and dry matter. While the RGR and NAR of dry matter were the same as that of 0.50 WUF.

The relevant data given in Table 45 on yield contributing characters showed that the length of earhead, girth of earhead, height of earhead, length of peduncle, diameter of peduncle were influenced significantly by irrigation treatments.

Irrigation application at 0.75 WUI showed significant increase in the values of these characters than irrigation application at 0.50 WUI. The application of additional quantity of water by increasing the frequency and reducing the interval helped in enhancing these characters during summer. Similar effects in case of grain and bhoosa yields of earhead, test weight, number of grains per earhead and grain and kadbi yields were observed. Irrigations at the rate of 0.75 WUI proved significantly beneficial than irrigations at 0.50 WUI. The ratio of grain to kadbi studied, however, was wider in case of 0.50 WUI as compared to 0.75 WUI. Irrigation application with 0.75 WUI helped in accumulating more of dry matter in grains as compared to 0.50 WUI. The higher soil moisture status maintained by irrigations at 0.75 WUI throughout the growth period thus helped in increasing the growth and yield attributes and finally the yield of both grains and kadbi. The similar increase in sorghum yield due to frequent irrigations than dry regimes was also noticed by Painter and Leamer (1953), Mathers et al. (1960), Meli et al. (1970) and Dastane et al. (1970).

The total uptake of nitrogen per plant at harvest was more in case of 0.75 WUI. So also total removal of nitrogen per hectare was more in case of 0.75 WUF. Thus additional quantity of water by reducing interval and increasing frequency proved useful in absorbing more of nitrogen. Adams (1970) observed such effects of higher moisture status resulted from mulch as the nutrient-s uptake. The nitrogen due to 0.75 WUI however, was not concentrate-d in grains, stem and leaves as much as due to 0.50 WUF. The crude protein content of grain was also more in case of irrigations with 0.50 WUF. This might be because of comparatively more difference in yields of grains and kadbi than the difference in nitrogen uptake by these two treatments. Finally irrigation application at 0.75 WUF proved significantly better as it helped in more of total nitrogen removed and in producing significantly more grain and kadbi yields.

The consumptive use of jowar due to different irrigation treatments was different. The consumptive use in the treatment of 0.75 WUF was more by about 100 mm during entire season. There was difference also in the per day consumptive use. In the treatment of 0.75 WUF, the consumptive use was 5.0 mm and in case of 0.50 WUF the consumptive use was 4.2 mm. The grain yield of jowar was more due to irrigations at 0.75 WUF with 639.5 mm consumptive use than the treatment of 0.50 WUF with 539.0 mm consumptive use. The additional yield of 4.87 q/ha due to 0.75 WUF, required proportionally more quantity of water during the season than at 0.50 WUF level. This could be seen from the fact that the moisture use efficiency at 0.50 WUF level was comparatively more (8.54 kg/ha/mm of water) then the moisture use efficiency at 0.75 WUF (7.96 kg/ha/mm of water). This might be because of slightly luxurient use of moisture from the 0.75 WUF treatment wherein soil moisture regime was comparatively high throughout the season than in case of 0.50 WUF.

The studies on the dry weight of weeds removed from *jowar*, at harvest, during summer (Table 42) indicated significantly more growth of weeds in case of application of more quantity of irrigation water with more number of irrigations and shorter intervals as compared to less quantity of water applied in less number of irrigations with larger interval. This indicated that the additional water helped in enhancing the weed growth alongwith the crop growth. Availability of less water for crop growth thus comparatively reduced the weed growth.

The studies on soil temperatures at 10 cm depth (Table 43) evidenced that the soil temperature in different irrigation treatments on 100th day of growth was same. On the day of observation, however, the soil moisture may be nearly the same as by chance irrigations were applied on the same day before observation in both the irrigation levels.

Mulches :

The data regarding growth characters presented in Table 44 revealed that the mean height per plant was more in case of sugarcane trash mulch than other two mulch treatments on 60th and 90th day of growth and at harvest, At 30 days, however, there was no such difference observed in case of height as mulch treatments were not effected till 30th day of observation. Bitumen mulch also influenced the plant height more than no mulch treatment during entire growth period. This clearly revealed that mulch helped in increasing the growth in terms of height of jowar. Similar trend was also noticed in case of mean number of functional leaves and mean leaf area per plant on 60th and 90th day of growth and at harvest. However, the difference was noticed more with the advancement in the age of the crop. The difference in the mean leaf area and mean leaf number per plant remained throughout despite the dropping of leaves with the advanced growth of the crop. Sugarcane trash mulch was thus effective in increasing the growth of jowar during summer in respect of mean functional leaf number and leaf area per plant than bitumen mulch and no mulch treatment. No marked differences were, however, noticed between the effects of bitumen mulch and no mulch treatment. This indicated that the application of bitumen at the rate of 2 tonnes per hectare was not beneficial in enhancing the growth of jowar during summer. The bitumen failed to show its effect on jowar growth as mulch mainly because it could not form a thick film on soil surface sprayed, further, it could not be sprayed on entire space between two lines.

The data on dry matter per plant on different days of growth presented in Table 44 revealed the similar trend. Sugarcane trash mulch markedly increased the dry weight of jowar than bitumen and no mulch treatments on all the days of observation after its use. Bitumen mulch, however, did not show beneficial effect than no mulch treatment in increasing dry matter per plant. The growth functions studied also indicated that sugarcane mulch was beneficial in enhancing the growth of jowar during summer than other two treatments. Bitumen mulch and no mulch treatments did not show the difference.

The data on yield contributing characters and yield of grain, bhoosa and fodder presented in Table 45 revealed that sugarcane trash mulch enhanced markedly the yield attributing characters such as length and girth of earhead, length and diameter of peduncle than bitumen mulch and control. Thus application of sugarcane trash mulch at the rate of 5 tonnes/ha was beneficial in increasing the above yield attributes. The similar effects were also noticed on the characters such as number of grains per earhead, test weight of grains, weight of grains and bhoosa per earhead and grain and kadbi yield per hectare. Slight increase in these characters was noticed because of bitumen mulch than no mulch. However, this slight difference did not help in significantly increasing the grain and kadbi yields of jowar under summer conditions than no mulch. The beneficial effect of mulch in enhancing the growth, yield contributing characters and yield of jowar was also noticed by different scientists in India (Pal and Pandey, 1969; Umrani et al., 1973; Ravindranath et al., 1974; and Lane, 1977). The increase in growth and yield of other crops due to different type of mulches was also evidenced in India and abroad (Borstand Mederski, 1957; Moody et al., 1963; Choudhary and Chattarjee, 1967; Greb et al., 1970; Tiwari et al., 1970; Bansal et al., 1971; Myhre and Sanford, 1972; Patel et al., 1973 and Ali and Prasad, 1976).

The data in Table 45 evidenced that the percentage concentration of nitrogen was less in all the plant parts in case of sugarcane trash mulch as compared to bitumen mulch and no mulch treatment. However, the bitumen mulch did not show much difference in the effect on percentage concentration of nitrogen than no mulch treatment, indicating thereby that bitumen did not act as mulch effectively as that of sugarcane trash. The uptake of nitrogen and removal of nitrogen per hectare per plant was more in case of sugarcane trash mulch than the other two mulch treatments which showed the similar effects. The percentage of total nitrogen removed per plant in grains was less due to different mulch treatment. This indicated that mulch was not effective in accumulating more nitrogen in grains. The total nitrogen removed per hectare was more in case of sugarcane trash mulch than other two mulch treatments. The percentage of crude protein was less in grains of the treatment of sugarcane trash mulch as against the other two mulch treatments, though the total nitrogen removed was more and the percentage of nitrogen in grain, in relation to total plant was almost the same in all treatments(Table 39). The yield of crude proteins per hectare was more under sugarcane trash mulch treatment, as compared to other two treatments. Here again bitumen mulch did not show difference than that of no mulch treatment.

It is evidenced (Table 46) that the consumptive use in case of sugarcane trash mulch was comparatively less by about 40 mm during the season than other two mulch treatments. There was no difference in consumptive use due to bitumen and no mulch treatment. This clearly indicated that the evaporation losses were considerably reduced by sugarcane trash mulch as compared to bitumen mulch and no mulch treatment. Bitumen as a mulch was not effective in checking up the soil moisture loss through evaporation as the seasonal consumptive use was almost the same in both bitumen and control. The probable reason for the ineffectiveness of the bitumen may be attributed to the fact that it did not form required film on soil surface. Further more, the mulch could not be sprayed in all the space between rows. Only 25 cm was covered out of 45 cm space due to application difficulty. The data on per day consumptive use also showed the similar trend.

Moisture use efficiency was however, considerably high in case of sugarcane trash mulch as against other two mulch treatments. This indicated that sugarcane trash reduced the evaporation losses and almost all the water consumed was used for transpiration and metabolic activities. Thus, sugarcane trash mulch helped in reducing consumptive use and in increasing moisture use efficiency than other two mulch treatments.

The dry weight weeds removed at harvest indicated favourable effect of sugarcane trash mulch as it reduced considerably the dry weeds per hectare. In short, sugarcane trash mulch supressed the weed growth mainly through depriving the weeds of radient energy. The bitumen mulch however failed in showing the favourable effects as that of sugarcane mulch. The supression of weeds by sugarcane trash mulch might have reduced the competition for space, sunlight, nutrients and mostly soil moisture which in turn might have helped in increasing the growth and yield of jowar under summer conditions.

The similar effects of mulch on weed growth were also noticed by various workers (Chandra Mohan, 1970; Chakraborty, 1971; Patel et al., 1973 and Ravindranath et al., 1974).

The sugarcane trash mulch also showed its favourable effect on soil temperature at 10 cm depth (Table 43) as it reduced the soil temperature by 2°C specially under summer conditions. This lowering down of temperatures might be because of the reflection of radiation due to mulch cover on soil surface. The reduction in soil temperatures during summer due to sugarcane trash mulch might have helped in increasing the activities of roots, further in reducing the rate of evaporation of soil moisture. The similar effects of mulch application on soil temperatures and the crop growth were also evidenced in India and abroad (Schaller and Evans, 1954; Choudhari and Prihar, 1972; Patel et al., 1973 and Ravindranath et al., 1974). Bitumen did not show the similar effects as that of sugarcane trash mulch on soil temperature. This might be because of its failure in forming a film on the surface and failing in reflecting the radiations.

The growth and yield of jowar during summer was thus increased by sugarcane trash much mainly through its effect in conserving more of soil moisture by checking surface evaporation. The supression of weeds by sugarcane trash mulch might have also helped in making available more space, nutrients, light and moisture for jowar plants. The soil temperatures reduced by the mulch specially under hot climate might have also helped in increasing the activities of roots in absorption of nutrients and water. The favourable effects thus exhibited by sugarcane trash mulch helped in increasing the growth and in turn the yield of jowar during summer. Bitumen as a mulch however, failed to show its effects on conserving soil moisture, controlling weeds and reducing soil temperature and was not effective in increasing the growth and yield of jowar during summer. Its effect on growth and yield of jowar and on uptake of nitrogen were almost similar to that of control.

Interactions :

Though the attempt has been made in foregoing sections of this chapter to bring out effects of various factors on growth, yield, nitrogen uptake, consumptive use, weed growth and soil temperature, the picture would not be complete without considering the effects of interactions of the factors involved in the study. The irrigations and varieties are agronomically very important. The mulch application in relation to soil moisture conservation under different soil moisture regimes is very important, hence the combinations of these factors are bound to show significant effects. The interaction effects observed in the present investigation are discussed as follows.

Varieties and irrigations :

Plant height, leaf area and dry matter was significantly influenced by the combined effects of varieties and irrigation levels. Hybrid CSH-8R when irrigated with higher frequency and more total quantity of water showed tendency in increasing the height significantly than rest of the combinations. Higher frequency of irrigation also found beneficial in enhancing the height in case of variety No. 168 also.

At 90 days, leaf number per plant was also enhanced significantly and found maximum in variety No. 168 applied with irrigation at 0.75 WUF. This might be because of the genetical potential of the variety and more availability of soil moisture in case of frequent irrigations.

Mean leaf area was also influenced by the combination. More frequent irrigations produced more leaf area in case of hybrid CSH-8R at 90 days while in case of variety No. 168 at harvest. This might be because of larger size of leaf in case of hybrid CSH-8R and more number of leaves and less percentage dropping of leaves till harvest in case of variety No. 168.

The studies on total dry matter per plant and its components at harvest, also revealed, that dry weight of leaves was maximum of variety No. 168 at higher frequency of irrigation than rest of the combinations. Earhead weight was, however, more in case of hybrid CSH-8R with higher frequency of irrigation than other combinations. This might be because of the genetical potential of the hybrid CSH-8R in respect of its ability to transform the accumulated dry matter in a reproductive part. Higher frequency of irrigation aided these varieties to show the potential difference more than less frequent irrigations. In short, variety No. 168 under both irrigation levels failed in converting the accumulated dry matter in reproductive parts as much as that of hybrid CSH-8R. Girth of earhead, weight of earhead, weight of grains per earhead and thousand grain weight were observed maximum in the combined effect of hybrid CSH-8R and more number of irrigations. Frequent irrigations helped in increasing these characters in case of both the varieties. Hybrid CSH-8R might have the genetical potential which might have enhanced the growth in terms of above yield attributing characters than variety No. 168. This effect was further observed in grain yield. Hybrid CSH-8R with higher number of irrigations produced significantly more grain yield than rest of the combinations. The effect of the combination of hybrid CSH-8R and more number of irrigation on the yield attributes thus further helped in increasing the grain yield per hectare than other combinations.

Varieties and mulches :

The studies on plant height indicated that hybrid CSH-8R when grown with sugarcane trash mulch, produced significantly more plant height at all the stages of growth than the rest of the combinations. This might be attributed to genetical potential of hybrid CSH-8R and more favourable effect of sugarcane trash mulch in keeping the higher soil moisture status by checking evaporation than rest of the mulch treatments.

The leaf area per plant was significantly increased by the combined effect of hybrid CSH-8R and sugarcane trash mulch at earlier growth stage of 60 days when there was no dropping of leaves and might be because of the larger leaf size of hybrid CSH-8R than the variety No. 168. However, this effect was faded away at harvest and variety No. 168 showed more leaf area with sugarcane trash mulch, at harvest, than other combinations. Sugarcane trash mulch thus, increased the leaf area than other mulch treatments but the difference in genetical potential in respect of leaf size, leaf number and dropping of leaves in varied degree of varieties showed the different effects at both the stages of observations.

The length of earhead, length of peduncle, weight of earhead, weight of grains per earhead and thousand grain weight were also influenced significantly by the combination of varieties and mulches. Sugarcane trash mulch increased the values of these characters in case of hybrid CSH-8R than rest of the combinations. The yield was also influenced in keeping with the yield contributing characters mentioned above and thus maximum grain yield was obtained from hybrid CSH-8R with sugarcane trash mulch.

Here again the genetical potential of hybrid CSH-8R in producing higher values of these characters than variety No. 168 were further enhanced by the more soil moisture status effected by the sugarcane trash mulch than other mulch treatments.

Irrigation and mulches :

The growth measured in terms of leaf area at 90 days, stem weight at 60 days and weight of reproductive parts at 60 and 90 days was influenced significantly by the combined effect of irrigation and mulches. The higher frequency of irrigation and sugarcane trash mulch increased the above growth attributes than rest of the combinations. This indicated that the higher level of soil moisture status created by the above combination was beneficial in increasing the growth of jowar.

The weight of earhead and weight of grains per earhead and finally yield of grain were increased significantly by the combination of more frequent irrigations and sugarcane trash mulch than rest of the combinations.

Chapter VI

SUMMARY AND CONCLUSION

Chapter VI

SUMMARY AND CONCLUSION

An agronomic investigation, the results and finding of which have been discussed in the foregoing chapters was planned and conducted to study the effects of two irrigation levels viz. irrigations at 0.50 WUF and 0.75 WUF and three mulch treatments namely sugarcane trash mulch at the rate of 5 t/ha, bitumen mulch 2 t/ha and control on the growth and yield of hybrid CSH-8R and a variety No. 168 under summer conditions in the instructional farm of the Mahatma Phule Krishi Vidyapeeth, Rahuri during summer, 1977.

Besides the data on yield and yield attributing characters, the periodical observations on plant growth, in respect of plant height, leaf number, leaf area and total dry weight per plant and its components were recorded. These growth observations were used to analyse the growth behaviour during summer with the help of Absolute Growth Rate (AGR), Relative Growth Rate (RGR) and Net Assimilation Rate (NAR). The percentage concentration of nitrogen in different plant components was determined at harvest and the total uptake of nitrogen was worked out. The quality of grain was determined by estimating the protein contents. The seasonal consumptive use, mean daily consumptive use and the moisture use efficiency by jowar under summer conditions were also worked out. In addition the quantity of weeds removed at harvest and soil temperatures on 100th day of crop growth were also recorded.

The important findings of the investigation are summarised below :

A. Crop growth and development :

1. The mean maximum height of 108.10 cm was attained by *jowar* during summer.

2. The mean maximum functional leaf number was 11.82 at 60 days growth and thereafter the number was reduced to 8.05 at harvest indicating 31.9 per cent reduction in functional leaf number from 60 days of growth to harvest.

3. The mean maximum leaf area of 34.33 dm^2/plant was observed at 60 days growth which was reduced to 23.32 dm^2 per plant at harvest. The leaf area index was 5.08 at 60 days growth as against 3.45 at harvest.

4. The mean total dry weight per plant was 115.4 g at harvest, out of which 46.96 g i.e. 40.7 per cent was contributed by earhead followed by stem and leaves.

5. The mean maximum AGR of height of (1.62 cm per day during 31 to 60 days growth period was observed. The mean maximum RGR of plant height of 0.045 cm per day was observed during 31 to 60 days growth period of *jowar* during summer.

6. The mean maximum AGR of 1.88 g per day per plant was observed during 31 to 60 days growth period while mean maximum RGR of 0.070 g per day per plant during 31 to 60 days growth period and maximum NAR of 0.0991 g/dm^2/day was observed during 31 to 60 days growth period.

7. The mean length and girth of *jowar* earhead, during

summer, was 18.38 cm and 15.52 cm respectively which showed the ratio of 1:0.85.

8. The mean length and diameter of peduncle was 27.00 cm and 0.96 cm respectively during summer.

9. The mean weight of earhead was 46.96 g. The mean weight of grains and that of bhoosa per earhead was 38.79 g and 8.26 g respectively. This showed that the grains contributed to 82.6 per cent of the total earhead weight.

10. The mean thousand grain weight was 28.29 g, while the mean number of grains per earhead was 1490.40.

11. The mean grain yield per hectare of jowar was 48.50 q/ha and that of kadbi was 103.75 q/ha which showed 2.14 as the ratio of grain to kadbi under summer conditions.

12. At harvest, percentage concentration of nitrogen was maximum in grain to the tune of 1.39 per cent, it was followed by leaves and stem (0.74 and 0.44 per cent respectively).

13. The mean nitrogen uptake per plant was 0.936 g, out of which, 0.536 g was in grain, 0.234 g in leaves and 0.166 g in stem. The mean quantity of nitrogen removed per hectare was 131.65 kg/ha under summer conditions. On an average jowar grains contained 8.66 per cent crude protein.

14. The mean consumptive use of jowar during summer was 588.3 mm. The arithmetic mean of the consumptive use per day was 4.7 mm and moisture use efficiency by jowar during summer was 8.27 kg/ha per mm of water.

15. Despite the one weeding done after 26 days, 5.28 quintals of dry weeds were removed per hectare from <u>jowar</u> field at harvest during summer.

16. The mean soil temperature at 10 cm depth on 100th day in jowar field during summer was 32.6°C.

B. <u>Varieties</u> :

1) The growth measured in terms of height upto harvest, leaf area upto 90 days growth was more in case of hybrid CSH-8R than variety No. 168. The height at harvest, was 120.88 cm in case of hybridcCSH-8R and 95.31 cm in case of variety No. 168. The leaf area, however, after 90 days was more in case of variety No. 168. At 90 days and at harvest, the leaf area was 30.41 and 22.95 dm^2 respectively in case of hybrid CSH-8R and 28.00 and 23.68 dm^2 respectively in case of variety No. 168. The leaf size of hybrid CSH-8R was more than variety No. 168.

2. Mean functional leaf number was more from 60 days growth till harvest, in case of variety No.168. At harvest it was 8.57 in case of variety No. 168 as against 7.53 in case of CSH-8R. There was less dropping of leaves in case of variety No. 168.

3. The total dry weight was more in case of hybrid CSH-8R upto 90 days growth. At harvest, however, total dry weight per plant was maximum in case of variety No. 168. The contribution of earhead to the total dry weight was more in case of hybrid CSH-8R.

4. The growth functions such as AGR of plant height

showed the higher values during both the periods of observation, in hybrid CSH-8R than variety No. 168. The similar trend was also observed in AGR of dry matter. The RGR of plant height and dry matter per plant during both the periods of observation showed more or less the same values in case of both the varieties. The NAR of dry matter per plant was more during both the stages in case of variety No. 168.

5. Hybrid CSH-8R produced more mean length (22.60 cm) and girth (15.99 cm) of earhead than variety No. 168.

6. Mean length of peduncle of hybrid CSH-8R was more (29.65 cm) while the diameter of peduncle was more (1.01 cm) in case of variety No. 168 as against 0.90 cm of hybrid CSH-8R.

7. The mean weight of earhead (50.52 g), mean weight of grains per earhead (42.76 g) and mean thousand grain weight (32.15 g) of hybrid CSH-8R were more than variety No.168.

8. Variety No. 168 produced more weight of <u>bhoosa</u> per earhead (8.85 g) and more number of grains per earhead (1536.78) than hybrid CSH-8R.

9. Mean grain yield of hybrid CSH-8R was 55.47 q/ha as against 41.48 q/ha of variety No. 168. CSH-8R thus produced 33.0 per cent more grain yield.

10. The <u>kadbi</u> yield of variety No. 168 (107.94 q/ha) was more than the <u>kadbi</u> yield of hybrid CSH-8R. Variety No. 168 thus produced .9 per cent more <u>kadbi</u> yield.

11. The grain to <u>kadbi</u> ratio was wider (2.60) in case of variety No. 168 than the ratio of hybrid CSH-8R.

12. The mean crude protein content of grain of variety No. 168 was 8.88 per cent and was more than that of hybrid CSH-8R which was 8.44 per cent.

13. The values of percentage concentration of nitrogen in different plant parts at harvest were higher in case of variety No. 168 than hybrid CSH-8R.

14. There was no difference in nitrogen uptake per plant and total uptake per hectare in case of both the varieties under study.

15. The mean seasonal consumptive use was 599.7 mm of variety No. 168, which was more than that of hybrid CSH-8R (561.1 mm). There was no difference in mean daily consumptive use by these two varieties.

16. Moisture use efficiency of hybrid CSH-8R was 9.88 kg/ha/mm while it was 6.92 kg/ha/mm of water in case of variety No. 168.

17. Varieties under study had no differential influence on weed growth and soil temperature.

Irrigations :

1. The growth of jowar studied in respect of mean plant height, mean number of functional leaves per plant, mean leaf area per plant and mean dry weight of plant and its components during all the stages of observations influenced by irrigation levels. Irrigations applied at 0.75 WUF increased the growth in respect of all the above characters than irrigations at 0.50 WUF. The higher soil moisture status maintained throughout

the growth due to more frequent irrigations with shorter intervals, thus enhanced the growth of jowar during summer. At harvest, the mean plant height, mean functional leaf number per plant, mean leaf area per plant and mean dry matter per plant due to irrigations at 0.75 WUF were 113.09 cm, 8.15, 23.68 dm^2 and 119.76 g respectively as against 103.10 cm, 7.95, 22.95 dm^2 and 112.09 g respectively due to irrigations at 0.50 WUF.

2. Growth in respect of height and total dry matter studied with the growth functions such as AGR, RGR and NAR during 31 to 60 and 61 to 90 days growth periods also evidenced the similar trend i.e. irrigations at 0.75 WUF increased the growth rates during both the periods under study than irrigations at 0.50 WUF.

3. The yield attributes such as meanlength and girth of earhead, mean length and diameter of peduncle, mean weight of earhead and that of grains and bhoosa per earhead, number of grains per earhead and thousand grain weight were all increased significantly due to higher soil moisture status maintained throughout the growth period due to irrigations at 0.75 WUF than the irrigations at 0.50 WUF.

4. Mean grain yield of 50.88 q/ha and mean kadbi yield of 106.79 q/ha were more due to irrigations at 0.75 WUF than 46.01 q/ha and 99.38 q/ha that of grains and kadbi respectively due to irrigations at 0.50 WUF. The increases in grain and kadbi yields were to the tune of 10.5 and 7.5 per cent respectively.

5. The grain to kadbi ratio was narrow (2.10) in case of irrigations at 0.75 WUF as compared to irrigations at 0.50 WUF (2.16).

6. The crude protein content was 8.88 per cent in case of irrigations at 0.50 WUF as against 8.50 per cent in case of irrigations at 0.75 WUF.

7. There was no much difference in nitrogen removal per hectare in case of both the irrigation levels.

8. The seasonal consumptive use was 639.5 mm in irrigations at 0.75 WUF, while it was only 539.0 mm in case of irrigations at 0.50 WUF.

9. The moisture use efficiency was 8.54 kg/ha/mm of water due to irrigations at 0.75 WUF, while it was 7.96 kg/ha/mm of water in case of irrigations at 0.50 WUF.

10. The quantity of weeds removed at harvest, from jowar field in the irrigation treatment at 0.75 WUF was 6.84 q/ha as against 4.95 q/ha in case of irrigations at 0.50 WUF. As in case of growth and yield of jowar weed growth was also enhanced by higher soil moisture regime maintained due to frequent irrigations at 0.75 WUF.

Mulches :

1. The growth of jowar studied in respect of mean plant height, mean number of functional leaves per plant, meanleaf area per plant and mean dry weight of plant and its components during all stages of observations were influenced by mulch treatments. Sugarcane trash mulch increased the growth in

respect of all the above characters than bitumen mulch and no mulch treatments. At harvest, the mean plant height of 113.47 cm, mean functional leaf number per plant of 8.23, mean leaf area per plant of 24.35 dm^2 and total dry matter per plant of 122.65 g were observed in case of sugarcane trash mulch treatment. Bitumen and control did not show differential influence on the above growth characters.

2. The yield attributes such as mean length and girth of earhead, mean length and diameter of peduncle, mean weight of earhead and that of grains and <u>bhoosa</u> per earhead and thousand grain weight were all increased due to application of sugarcane trash mulch at the rate of 5 t/ha than other two mulch treatments which showed more or less similar effects.

3. Mean grain yield of 51.42 q/ha and that of <u>kadbi</u> yield of 108.38 q/ha, were obtained from the treatment of sugarcane trash mulch. The grain and <u>kadbi</u> yields due to bitumen mulch and no mulch treatments were more or less equal and were much low than due to sugarcane trash mulch. Sugarcane trash mulch produced 9.9 and 7.5 per cent more grain and <u>kadbi</u> yields respectively.

4. Grain to <u>kadbi</u> ratio of 2.15 was comparatively wider in case of no mulch treatment.

5. The crude protein content of grain of 8.81 per cent was more due to control.

6. Total nitrogen removed per hectare (134.55 kg) was slightly more in case of sugarcane trash mulch than other two mulch treatments.

7. The seasonal consumptive use was of 568.1 mm in sugarcane trash mulch treatment. This was comparatively less as against 609.4 mm under no mulched conditions.

8. The moisture use efficiency was maximum of 9.05 kg/ha per mm of water in case of sugarcane trash mulch as against 7.68 kg/ha/mm of water and 7.76 kg/ha/mm of water in case of no mulch and bitumen mulch treatments respectively.

9. The quantity of weeds removed at harvest from jowar field from sugarcane trash mulch was 4.41 q/ha which was around 60 per cent of the weed removed from the bitumen and no mulch treatments.

10. Application of sugarcane trash mulch reduced the soil temperature at 10 cm depth by 2°C during summer than bitumen mulch and control.

Interactions .

Varieties x Irrigations :

1. Mean height of CSH-8R with irrigations at 0.75 WUF was more throughout the growth period than other combinations. At harvest, it was 124.52 cm.

2. At 90 days, variety No. 168 showed maximum functional leaf number of 9.60 when irrigated with 0.75 WUF. It was more than rest of the combinations.

3. Mean leaf area at harvest was maximum of 24.14 cm per plant in case of variety No. 168 irrigated with 0.75 WUF than rest of the combinations.

4. The dry matter of leaves (35.63 g) at harvest was maximum in case of variety No. 168 irrigated at 0.75 WUF than rest of the combinations.

5. The dry weight of earhead at harvest was 51.08 g of hybrid CSH-8R applied with irrigations at 0.75 WUF than rest of the combinations.

6. Girth of earhead (16.16 cm), weight of grains per earhead (43.26 g) and thousand grain weight (32.53 g) were observed maximum in the combined effect of hybrid CSH-8R and irrigations at 0.75 WUF than other combinations.

7. The grain yield of 56.44 q/ha was observed as a combined effect of hybrid CSH-8R and irrigations at 0.75 WUF.

Varieties x Mulches :

1. Plant height in hybrid CSH-8R with sugarcane trash mulch was maximum 128.29 cm at harvest than rest of the combinations.

2. At harvest, the maximum leaf area 24.54 dm^2 per plant was observed in combined effect of variety No. 168 with sugarcane trash mulch, which can be attributed mainly to the more number of leaves of variety No. 168.

3. The length of earhead (21.71 cm), length of peduncle (31.12 cm), weight of earhead (53.43 g), weight of grains per earhead (45.30 g) and thousand grain weight and finally grain yield (59.35 q/ha) were all due to combined effect of hybrid CSH-8R and sugarcane trash mulch. These values were maximum and more than rest of the combinations.

Irrigations x Mulches :

1. The leaf area at 90 days growth (31.14 dm^2) dry weight of stem at 60 days (32.06 g) and that of reproductive part at 60 days (7.37 g) and 90 days (39.44 g) were maximum in case of sugarcane trash mulch with more number of irrigations.

2. The weight of earhead (51.05 g), weight of grains per earhead (42.10 g) and grain yield (54.53 q/ha) were maximum in the combination of sugarcane trash mulch and more number of irrigations at 0.75 WUF.

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