EFFECT OF IRRIGATION FREQUENCIES AND MULCHES ON THE YIELD OF SUMMER CHOLAM (*Sorghum vulgare* Pers.)

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C O N T E N T S

LIST OF ILLUSTRATIONS

In India, water is sold to the cultivator on an acre basis, and there had been not much stress on how efficiently he uses the irrigation water. In consequence, adequate return on the huge capital outlay are not being secured now, and irrigation systems are at present working at a loss in almost all States. Lift irrigation methods also leave much to be desired. The second Finance Commission has drawn attention to the deterioration which had occured in the net receipt from irrigation projects and had suggested inter alia, economy in the use of irrigation supplies.

Efficient irrigation practices, in addition to the saving in cost of water utilized, serve to irrigate extra land, resulting in increased production and extra income from, land which otherwise would have remained unproductive.

One basic question therefore arises, which needs clarification, as to what extent the soil moisture supply can be reduced without causing decline in yield?

Availability of water over a wide range of soil moisture content, and more especially its equal availability over that range is a matter of some dispute. According to one school of thought, water is either available or not available to plants, and it is equally available over the entire range from field capacity down to the wilting point, where it becomes unavailable to plant growth.

In contrast, it was shown by many others that growth of plants was slowed down by decreasing soil moisture, and it ceased before the soil moisture content fell to the wilting percentage. Growth of many plants were reported to be increased with increasing soil moisture almost to saturation.

Cholam (Sorghum vulgare PERS.) is reputed for its hardiness and high water use efficiency, and an investigation with that crop, on the problem of water availability and the limit to which irrigation frequencies could be reduced, without hampering its productive capacity, was thought to be worth while.

Besides that, another question also arose, as to the possibility of avoiding or limiting the loss of moisture from the soil, now considered 'unavoidable'.

Losses by evaporation from the soil is considerably higher in semi-arid regions than in humid areas and constitute the single largest loss of water from the field.

Ways and means of cutting down this waste, had been the object of many investigations in the past. Many have tried creating a soil mulch and spreading foreign materials over the soil surface, with varying degrees of success. The economic aspect of the problem i.e., the possibility of growing crops in more area with the same irrigation water is of vital importance.

Work on this subject in Madras State and elsewhere is extremely limited. In an earlier study on the water requirement of cholam Co.18 in Madras State (Dhanapalan Mosi, Daniel and Mariakulandai, 1958) three levels of irrigations were found to be on a par and the possibility of raising Co.18 cholam under the lowest level of moisture, without any loss of yield was shown. On other crops like cotton, vegetablesetc., the effect of straw and polythene mulches in cowering moisture was demonstrated. The efficacy of soil mulch on moisture conservation was also evident from many previous works.

An investigation into the combined effect of these two factors, was however lacking.

Hence, with the above objects in view, this experiment was conducted to find out the relative effect of three frequencies of irrigation (three moisture regimes) and four types of mulches, on the yield and other attributes of Co.18 cholam.

CHAPTER II

REVIEW OF LITERATURE

1. MOISTURE AND PLANT GROWTH

Water is an essential nutrient for plant growth, and is needed in much larger quantities than any other (Russel, 1961). Scarcity, over abundance and excessive movement of water may, and do result directly in injury to plant life and in unbalancing soil conditions conducive to plant growth. Its importance in crop production had received attention from the early days of scientific thought in agriculture, and Johnson (1877), discussing the reasons for tillage, a very widely adopted agronomic practice, had suggested modification of water storage in the soil, as its main objective.

Dumenil (1950) found moisture, as the most important factor limiting corn yields and placed even nitrogen only second to it. Nelson (1956) considered all farm practices like, fertilization, adjustment of plant population and tilling of the soil as an essential arrangement for making the best use of existing moisture. The beneficial effect of enough water on growth and crop yield was recognised by many workers (Hallstead, 1937; Cole and Mathews, 1940; Painter and Leamer Ross, 1952; Fernandez and Laird, 1957; Sasso 1957; and Bever, 1960).

Opinion, however, is divided on the response of plants to varying moisture regimes (Lety and Peters, 1957;

Baver, 1960; Robins and Domingo, 1962). The nutrient content of plants were also found to vary according to the moisture regime (Moderski and Wilson, 1960).

Increasing food production is the need of the hour and water and its use is the one factor that can influence the same most. The land is plentiful and water scarce, and according to Widstoe (1912) and Russel (1961) the most efficient way of using the water was to apply small amounts of water over large area, rather than large amounts on small area.

In fact, workers on this problem have pointed out excessive water use, (Howard and Howard, 1909) and showed possibilities of limiting irrigations to the minimum (Khan and Desai, 1941; Mitra and Sabnis, 1945; Khan and Nathuram, 1947). With the irrigation potential that is being developed at a huge cost in this country, planning for better cropping systems and practices to reap maximum advantage of available moisture in irrigation project areas was emphasized by Shankaranarayan and Mehta, (1961).

Among the different crops, efficiency of millets in general and cholam in particular, to with-stand drought conditions and yet to give appreciable yield was observed by many (Briggs and Shantz, 1914; Glover and Lampkin, 1957; and Ratnaswamy, 1960).

Different moisture regimes affect plant growth and crop yields differently. Different external factors too, in their turn affect the moisture regime in the soil. Methods by which the moisture regime can suitably be altered or controlled are now well known. Mulches are considered to be potential means by which some control on moisture and related factors could be influenced. Some aspects of all these phenomena are reviewed in the following pages.

Plants grow equally well under different moisture regimes:

Veihmeyer and Hendrickson (1929, 1931, 1934, 1937 and 1942) have concluded that water is equally available to the plant over the entire range from field capacity down to the near wilting point. Adams (1942) and Doneen and Mc Gillivary (1943) seem to hold the same view. Kelly, Hunter and Hobbs (1945) found no difference on plant growth under varying degrees of soil moisture stress, and in fact, found that plants grew so well under severe moisture stress to which they were subjected.

Wheat yields in the loamy soils of Berlin, were no different in years when varying degrees of drought prevailed (Baumann, 1951). He could repeat the findings with pot culture experiments. Wheat yields under different levels of irrigation were found to be the same (Rao *et. al*. 1955; Gautham, 1961). The same trend was observed in Guayule and sweet potato (Hunter and Kelly, 1946; Jones, 1961; and Veihmeyer and Hendrickson, 1961). Shallow and deep irrigation had no significant effect on plant growth and yield (Sinha, 1959).

Nutrients other than Phosphorous did not show great variations with moisture stress (Bourget and Carson, 1962). The retarding effect of temporary moisture stress, on growth rate was partially compensated by a rapid growth rate following release of moisture stress in corn (Kemper et. al. 1961).

Plant growth best at medium moisture regimes:

Another school of thought holds the view, that plant grows best at medium levels of soil moisture conditions. With cotton and gram, Khudari (1962) found, soil moisture between field capacity and 75%, the most condusive for best plant growth and 50% moisture of field capacity was the lowest on which plants could be grown economically.

Growth and yield of maize was best when irrigation was resorted to, when available soil moisture was depleted by 20%, than that by 60% of the field capacity (Vazquez, 1961). Vittum, Peck and Carruth (1959) obtained more number of marketable cobs per plant, more cob weight, more unhusked maize and increased net yield of cut maize with medium moisture levels. Turnov (1961) also obtained better maize yields with medium moisture. Medium levels of irrigation was found to give the most economic returns too (Vittum, Peck and Carruth, 1959).

Growth of plants are proportional to moisture levels:

Yet another school of thought believes that ultimate growth of plants depend on the quantity of water supplied and is approximately proportional to the moisture levels in the soil. A number of studies (Lewis, 1935; Magness, 1935; Furr and Taylor, 1939; Wadleigh and Ayers, 1945; Wadleigh, Gauch and Magisted, 1946; Davis, 1949) had shown that water was not equally available over the entire range down to the wilting point. The dry weight of plant tops and roots developing in the soil was found to increase linearly with increasing soil moisture (Mederski and Wilson, 1960). Wheat growth and yield was proportional to the moisture supply in the soil (Brown and Shrader, 1959; Singh, 1960; Jackowska, 1961). The same trend was observed in maize by Alaggia (1957), Gard (1959) and Gard et. al. (1961). Growth of guayule shrubs were shown to be proportional to the moisture regime maintained by irrigation (Wadleigh, 1946; Wadleigh, Gauch and Magisted, 1946 and Tingey 1952). Growth of many a crop plant like maize, cotton, barley etc., were shown as roughly inversly proportional to the suction of water in the soil, decreasing continuously as the suction rises from about 1 atmosphere i.e., just drier than the field capacity (Davis, 1940; Adams, Veihmeyer and Brown, 1942; Haynes, 1948; Khreeb, 1957; Anthony and Ogborn, 1960; Bourget and Carson, 1962; Khudari, 1962).

Jenne et. al. (1958) found, plant height, dry matter, N, P, K, Mg, and Ca content of corn higher at higher levels of moisture. Increased growth and grain yield in cholam was reported with increasing soil moisture levels by Brown and Shrader (1959) and Musick and Grimes (1961).

Effect of high moisture contents in the soil

Maintenance of a very high level of moisture in the soil is not considered good. A study of water saturated soil (flooded and with 100% moisture of its water holding capacity) on barley plants showed that in the early phase of plant growth, it effects an acute change in the course of physiological processes i.e., lowering of the absorptive function of roots in regards to water and nutrients, and an increase in the oxidative processes, which suppress the plant growth and development and thereby lowers the yield (Savickaja, 1959). He however observed that such condition during the critical periods of plant did not produce such determinal effect on the yield and only slightly lowered the yield by stimulating certain growth processes.

Soil moisture near field capacity was not the best for cotton and gram (Khudari, 1962). He found that frequent irrigations provided little oxygen to the roots, thus reducing the rate of absorption of nutrients. Increased uptake of fertilizer Phosphorous was reported in oats at moisture levels nearing field capacity (Simpson, 1960).

Effect of too little moisture in the soil:

Growth rate and total leaf area decreased with very dry conditions in the soil. This phenomenon was reported in wheat (Konovolov, 1959; Scerbakov, 1959; Jackowiska, 1961; Robins and Domingo, 1962), in corn (Robins and Domingo, 1953; Denmead and Shaw, 1960) and in barley (Orchard, 1961).

Severe yield reduction in guayule was reported by Hunter and Kelly (1946). With moisture at near permanent wilting point very little growth of cotton and gram was noticed by Khudari (1962).

Nunez *et. al.* (1960) reported reduction in wheat yield under soil moisture stress; but increased protein content of the grain resulted.

Decrease in soil moisture content to near permanent wilting point resulted in decrease in respiration intensity especially in young leaves, and remoistening increased it only temporarily (Carlier, 1961). Reduced cob size and reduced fertilization from non-receptive silks resulted from depletion of moisture to the wilting point, during tasseling stage in corn (Robins and Domingo, 1953).

Asana and Saini (1958) observed inhibited stem growth, hastening of the yellowing of leaves and stem, and reduced grain numbers but increased grain size in wheat as a result of intermittent simulated drought during the post dehiscence stage. The same condition at the time of grain filling was found to increase at first the rate of ripening by increasing the translocation of nitrogen substances to the grain (Konovolov, 1959). At milk ripe stage, however, moisture deficiency caused ultimate lowering of grain yield due to lessened intensity of photosynthesis, and greater expenditure of organic substances through respiration.

Cholam was found superior in dry regions, for their ability in recovering the apperent pattern of stomatal behaviour after severe drought lasting for a fortnight or more, and their recovery followed fairly closely behind the restoration of turgidity to the leaves (Glover, 1959). Extraction of greater proportions of water from lower depths was reported as the moisture stress increased (Gard, 1959).

Grain yield in relation to soil moisture:

Cole and Mathews (1940) associated high milo yields, with large quantities of water in the soil at the time of planting. Higher wheat yields with high levels of moisture during plant growth was reported by Sasso (1958) in Italy, Brown and Shrader (1959) in Kansas and by Singh (1960) in India.

Increased maize yields were obtained when irrigation to meet the soil moisture losses were practiced (Alaggia, 1959; Gard, 1959; Gard, 1961; Trunov, 1961). Reduction in grain yield in wheat was reported by Robins and Domingo (1962) due to severe soil moisture stress. Similar trends in other crops were also reported (Kreeb, 1957 and Bourget and Carson 1962).

Bendelow (1958) found that irrigation increased grain yield and malting qualities of barley. But it lowered the nitrogen content of the grain. Yield reduction in wheat was found to be true even when the depeltion of soil moisture was only for short periods (Jackowska, 1961). Similar conditions, during tasseling, for one to two days reduced corn yield by 22% and for six to eight days by 50% (Robins and Domingo, 1953).

In cholam too, grain yield was higher when unlimited moisture conditions was provided, compared to limited irrigation regimes, and the yield was about four times higher then that obtained from non-irrigated plots (Musick and Grimes, 1961).

Straw yield in relation to moisture:

The direct effect of drought according to Russel (1961) was fundamentally on the amount of leaf the crop was able to carry. Moderate drought on an established cereal crop caused an appreciable loss of leaf, and therefore straw, without any loss of grain. Widstoe (1912) found that when irrigation was provided to a crop grown under moderately dry conditions, increasing the amount of irrigation water would correspondingly increase the amount of leaf, and hence straw yield, much more than that of the grain.

Straw yield in wheat was found to affect linearly with increasing or decreasing moisture, when the plants were subjected to such changes in the reproductive stage (Sasso, 1958; Jackowska, 1961). Similar trend was also reported in maize (Trunov, 1961). Leaf area was greater under higher levels of moisture than lower levels (Mann, 1957; Jaros 1959).

Dry matter production in relation to moisture regime:

Dry matter accumulation according to Mann (1959) was influenced more by moisture than by nutrients. Linear increase in dry weight with increasing moisture was reported in maize (Mederski and Wilson, 1960). Orchard (1961) reported reduced dry matter production and leaf area in barley under soil moisture stress, and reported modification of the above effect when water was provided later.

Root growth in relation to soil moisture regime:

According to Russel (1961) the soil affected plant primarily through its effect on the root system and the rate of root growth in turn depend on the temperature, water and air supply in the soil and on the amount of carbohydrates the aerial parts of plant translocated to the root system; and on the competition they suffered from other roots. With the exception of aquatic plants and a few epiphytes, plants absorb practically all their water through roots and the effectiveness of roots as absorbing surface depends on the extent of the root system and on the efficiency of individual roots. The importance of root system for proper maintenance of water balance in the plant and as a characteristic of drought hardy varieties was observed by Ivanov (1923), Khanna and Reheja (1947) and Misra (1966). Extensive root system was shown to absorb water from greater volume of soil (Talanov, 1926).

Low levels of moisture was found to increase the root depth in plants (Weaver and Himmal, 1930; Bennet and Doss, 1960) and the root weights (Hubbard, 1938 and Bennet and Doss, 1960). Increase in the number of roots per plant and more root hairs under such conditions was observed by Hubbard, (1938) and Kmock <u>et</u>. <u>al</u>. (1957). As the soil moisture stress increased, maize roots extracted more water from lower depths (Gard, 1959).

Holch (1931) and Duncan (1941) found root growth in tree seedlings, inversly proportional to the available soil moisture content. Cannon (1911), Weaver (1920) and Weaver and Crest (1922) found that the depth of penetration of root system depended on the depth to which the soil was wetted. But Shantz (1927) and Breazale and Crider (1934) were of the opinion that roots of at least certain species would penetrate into soil below permanent wilting point. However, Hendrickson and Veihmeyer (1931), Reed (1939), Kaufman (1945) and Muller (1946) considered such a possibility most unlikely under field conditions.

High soil temperature may limit root growth as also low temperature. Arndt (1945) found the optimum soil temperature for root elongation between 33 and 36^{o}C.

Competition with crop plants and weeds were found to reduce root growth considerably (Weaver and Kramer, 1932; Polychenko, 1937; Yocum, 1937; Coile, 1940).

Miller and Coffman (1919) reported that cholam had twice as many secondary roots as maize and the roots more fibrous, resulting in the better ability of the former to with-stand severe moisture stress.

2. MULCHES AND MULCHING

Buckman and Brady (1961) designated mulches, as any material used at the surface of soil primarily to prevent the loss of water by evaporation, or to keep down weeds. They varied from the top soil itself stirred and used as soil or dust mulch to several other foreign materials like organic residues. More recently a host of artificial materials have come into use on a wide scale.

Literature on the various kinds of mulching materials that have been tried over the years reveal the differing opinions as to whether or not they are beneficial for plant growth. Numerous types of mulches have been tried from rocks and stones, to slowly decomposing materials like saw dust, chips and shavings of wood, alfalfa and bean straw, hay, and manure (Lamb and Chapman, 1943). However, as reviewed by Jacks et. al. (1955) the majority of the writers conclude that mulches are useful in moisture conservation and tend to increase yields. Baver (1960) was of the opinion that artificial mulches greately retarded evaporation, protected the soil from direct rays of the sun and wind currents, consequently the soil was kept cool and the vapour pressure of the air within the mulch was more nearly the same as that within the soil air.

Polythene mulches are presently being used in increasing amounts by market gardeners, and pineapple growers (Emmert, 1956; Clarkson and Frazier, 1957; Carolus and Downes, 1958; Anon, 1959).

Hanks and Woodruff (1958) found the primary effect of mulches as increasing the length of vapour path, and the energy absorbed by the mulch had little influence on the water loss. Soil covering conserved moisture, kept soil temperature higher than that of bare soil and decreased frost penetration (Eimern, J. Van, 1961).

In contrast to the findings of the workers mentioned above many do not corroborate the beneficial effect of mulching. Cahoon, Stolzy and Morton (1961) with mulches of light and heavy wood shavings and black polythene, found water depletion the same, or when varied, of no significance. It was shown that moisture differences may exist in the top 0 to 6 inches of soil under the treatment, but when the entire root zone was considered the mulches did not conserve moisture, in amounts large enough to enable the grower to change his irrigation schedule. They also showed that the downward movement of water was not in any way different in the mulched plots than that in the unmulched.

Effect of mulches on soil temperature and plant growth:

Apart from affecting the soil moisture, mulches are found to influence the soil temperature. The effects of soil temperature on plant growth are manifold. With increased soil temperature emergence was hastened and earliness promoted in maize (Willis et. al., 1957). They found growth rate linear over 60 to 80°F. Burrows and Larson (1962) reported that growth rate of maize progressively retarded with decreasing soil temperature. Willis (1957) found 75°F at a soil depth of four inches to be the best soil temperature for maize growth in central Iowa.

Increased uptake of Phosphorous with increasing soil temperature was reported by Simpson (1960). Dormaar and Ketcheson (1960) found increased 'NP' uptake by maize, and Nielsen et. al. (1960) found increased 'NPK' uptake at higher soil temperature ranges. Baver (1960) reported high rate of organic matter decomposition and mineralization of organic nitrogen with increasing soil temperatures.

Brouwer (1969) obtained better growth of peas in Hoagland's solution at 11, 15 and 19°C compared to that at 7°C. Dry matter production also followed the same trend. High soil temperature accelerated plant development and hastened maturity, besides increasing grain yield in cholam (Adams, 1962). Lower maize yields under some mulches was attributed to the low soil temperature under them (Anon, 1960; Burrows, 1960).

<u>Effect of mulches on weed control and plant growth:</u>

Weed competition has remained always as an important factor limiting crop yields, and yet due to lack of proper understanding, high cost of labour or other inherent difficulties, weed control has never achieved perfection. Russel (1961) opined that permitting weeds to compete with crop plants was the greatest hazard to higher yields. Aspinall (1960) was of the opinion that root competition reduced growth more than did shoot competition, although the influence of the latter increased with time.

As the density of weeds increased, decrease in the yields of grain, cobs, stalks, and straw, diameter of maize stalk, ear weight, light intensity beneath the crop, and soil temperature were reported by Knake and Sliefe (1962). They made the general observation that, the total dry matter yield of crop and weed, and the yield of weed free crop were not much different.

Li (1960) and Nieto (1960) obtained increased yields of cotton in weeded plots. The same trend was observed in cotton by Chaugule and Khare (1961), in bajra (*Pennisetum typhoides*) by Khan and Mathur (1961), in wheat by Khan (1958) and Sinzer (1961), and in legumes by Smartt (1961) and Staniforth (1962).

From the very early times mulching as a cultural practice was intended to eliminate weeds from cultivated fields. Robinson (1957) from Jamaica reported complete control of weeds in coffee plantation by adopting mulching. Mathur (1960) reported effective control of nut grass (Cyperus rotundus LINN) by trash mulching in sugarcane fields.

Comparing different plastic films Spice (1959) did not observe any weed control under transparent film, as it allowed passage of sun light. Adrus et. al. (1958) obtained perfect weed control with black polythene film. Similar results were obtained in cotton in Coimbatore using black polythene film (Anon, 1961).

Mulching material include both the top layer of soil itself suitably disturbed to form a blanket on the surface, and any foreign materials, not already on the land. Foreign materials like saw dust, wood shavings, corn stalk, straw, trash etc., all of organic origin, and artificial materials like paint sprays, asphalt, tin foil, paper and polythene are used in mulching. Besides soil mulch, the most commonly available materials in each class, viz., trash and black polythene were used in this experiment. Previous work on the above three types of mulches are reviewed hereunder.

Soil mulch or the dust mulch:

The effect of soil mulch on conserving soil moisture and increasing plant growth and crop yields is a matter of discord from the time it was propounded first. The classical experiments by King (1907) was the first scientific approach to the problem of evaporation of water from soils, and conservation of moisture under soil mulch.

Blasse (1960) found that with repeated shallow cultivation during spring and summer months, the soil moisture content in the soil was affected favourably. Dotsenko (1960) was of the opinion that in the presence of a dry surface layer, the rate of evaporation would decrease with increasing thickness of the dry layer. A fine tilth containing predominently, soil crumbs of 2.5 m.m. diameter was more efficient in slowing down water loss from bare soil than coarse clods on the surface or no tillage (Holmes, Greacen and Gurn, 1960).

Moisture conservation was best under clean cultivation or dust mulch, then under grass sward, cover crop, saw dust, rye straw, peat, 400 guage polythene or leaf mulch and it gave the highest yields in cereals and fruit crops tried (Johansson, 1959; Soczek, 1959; Randhawa <u>et. al</u>. 1960; Rubin <u>et. al</u>. 1961). Loosening the top layer of moist soil decreased evaporation for a short period; but the decrease in evaporation was not persistent over a long period (Abramoua and Bolshakov, 1960). They however, found that the practice increased absorption of autumn precipitation by the soil.

The beneficial effect of dust mulch in conserving soil moisture was not observed by many workers. Veihmeyer (1927), Baver (1960) and others have shown that evaporation losses are confined relatively to shallow depths and most of the water is lost through evaporation, before the moisture content is lowered sufficiently to create a dust mulch on the surface.

Whatever may be the merits of dust mulch in conserving soil moisture, many workers have obtained beneficial results with the practice, as reflected in crop growth and yield. Birch (1960) found that drying increased the amount of organic matter that went into solution on moistening, and recommended it as a good practice to dry out the soil prior to irrigations.

Trash mulch:

Benefits like conservation of moisture, prevention of erosion, increased humus, increased thickness of arable layer, elimination of weed competition, and economy in its use were attributed to trash mulching (De silva, 1957). The marked effect of a sandy soil, taking entirely a different character and becoming granulated, after trash blanketing over some years, have been recorded (Anon, 1958).

Appreciable moisture conservation under trash cover was reported by Escer (1884); Johansson (1959); Miggirewa (1959); Baver (1960); Larson, Burrows and Willis (1960); Mathur (1960); Onchev (1960); Randhawa (1960); Eimern, J.Van (1961) and Lehne (1961). Increased yields with trash mulching was reported in maize (Collings, 1951), in sugarcane (Blundell, 1954; Bose, 1954; Mathur, 1960), in cotton (Gupta and Sharma, 1959), in grape and tobacco (Onchev, 1960) and in root crops (Lehne, 1961).

Lugo-lopiz et. al. (1952); Leake (1954); Bollen and Lu (1957); Peterson and Englebert (1957) and Larson, Burrows and

Willis (1960) reported no benefit or decrease in crop yields, especially in poor soils and in the absence of any additional nitrogen, while Willis (1957) and Burrows and Larson (1962) reported definite reduction in crop yields and prolonged growth periods, due to the application of trash mulch.

Many have observed the benefit of trash cover in supressing weed growth (Landrau and Samuels, 1952; De Silva, 1957; Mathur, 1960). Peterson and Englebert (1957) reported better erosion control while Karnatz (1959) and Russel (1961) reported the insulating effect of the trash layer in preventing exchange of heat.

Poor aeration due to high moisture and low soil temperature, both caused by the mulch, limited release of available nitrogen from soil organic matter (Parker, Larson and Bartholomew, 1958). Reduced yields due to the above defects and lower soil temperature was reported by Wollney (1883); Ap Griffith (1951); King (1953); Anon (1960); Oncheve (1960) and Burrows and Larson (1962).

Polythene mulch:

Of late, polythene films are being used in increasing quantities for mulching purposes especially in row crops and orchards, and Vlcek (1961) claimed conservation of moisture, promotion of cellulose decomposition and nitrification, increased CO_2 production, hastening of maturity and increased yields as some of its beneficial effects.

Polythene mulch was found to result in the least depletion of soil moisture (Shaw 1959; Randhawa, Singh and Dudani, 1960; Shadbolt, McCoy and Whiting, 1962). Some workers, however, have questioned the benefit of polythene mulch in conserving soil moisture. They were of the opinion that the warmer surface evaporated more moisture, and depending on the temperature-moisture relationships, actually, losses in moisture was more under a polythene mulch (Lemon, 1956; Cahoon, Stolzy and Morton, 1961).

A more profound influence of polythene mulch was on the temperature of the soil (Waggoner, 1958; Honma et. al. 1959; Clarkson, 1960; Vlcek, 1961 and Shadbolt, McCoy and Whiting, 1962). Maximum daily temperatures were somewhat higher and minimum temperature lower under black polythene (Honma et. al. 1959; Voth and Bringhurst 1959; Clarkson 1960; Waggoner 1960, Shadbolt, McCoy and Whiting 1962). Plastic covers were found unsafe for plant growth where temperature is usually too high (Army and Hudspeth, 1960).

Clarkson (1960) and Shadbolt, McCoy and Whiting (1962) observed that black polythene mulch reduced the movement and leaching of nitrate and thereby increased the utilization of it by the crop. Over feeding with nitrogen was found harmful as conservation of nitrogen under polythene mulch was considerable (Clarkson, 1960).

The literature reviewed in the preceding pages show the response of crops to varying soil moisture regimes. Though both extremes of soil moisture were found generally harmful, the variation in between the extremes were sufficient to affect crop yields differently and some crops were capable of adapting to restricted moisture conditions better. Mulches were found to influence the moisture regime, soil temperature and weed growth and thereby the yield and other attributes of crop plants.

Work in India on the effect of different moisture regimes and different types of mulches on crop growth and yield and more especially on a popular irrigated millet like cholam was sparse. Studies on the combined effect of the above two factors are virtually lacking.

And it is just the state of affairs - so relatively little accomplished, so much still to do, and the need so very great - that makes this field of work necessary and attractive.

CHAPTER III

MATERIALS AND METHODS

The experiment was laid out in Field No.77, Central Farm, Agricultural College, Coimbatore, in the summer season of 1962. The soil is of the black loamy type representing the typical garden land soils of the Coimbatore tract. The detailed analysis of the soil are furnished in the appendix.

Variety:

For the study, a popular high fertility strain, Co.18 cholam was selected. It is a cross between 'Agnikodai' and Co.9, a pure line selection from 'Kesarivellai'. The grain is of good quality and the straw is juicy and an excellent fodder much relished by cattle. This variety is a heavy yielder with duration of about 95 days. The seeds were obtained from the Millet Breeding Station, Coimbatore and the germination was found to be 94%.

Manuring:

All plots received 40 lb. nitrogen and 20 lb. phosphoric acid, in addition to a basal dressing of five tons of farm yard manure per acre, being the dose recommended in the Fertiliser Workshop (1959) held at Coimbatore. The farm yard manure and P_2O_5 in the form of super phosphate were incorporated by ploughing in, at the time of the last ploughing. Nitrogen was applied as ammonium sulphate and was broadcasted and raked in just before sowing.

Sowing:

Sowing was done on 13th March 1962, by dibbling the seeds in lines, 18 inches apart. The seedlings were thinned later, to keep a spacing of six inches in the line.

The crop was dusted with BHC 10% to control earhead bug attack as soon as the pest was noticed. The harvesting of the grain was done on 28th and 29th June and that of straw on the 4th and 5th July, 1962.

Experimental details:

(a) Lay out:-

Design	Split plot
Number of treatments	Twelve
Number of replications	Six
Size of plots (gross)	21'-2" x 21' (1.02 cents)
Size of plots (nett)	18'-2" x 18' (0.75 cents)
Spacing	18" x 6"

Since the investigation was to compare irrigation frequencies (major treatments) and different types of mulches as they affect the moisture regime (minor treatments), the split plot design was thought to be the most suitable.

The plant population was maintained constant, in all the plots, by proper thinning out and gap filling.

Irrigation frequencies:

As the local practice for cholam is to irrigate the crop once in 7 to 10 days, one treatment was to irrigate the crop once in 7 days so as to maintain a high moisture regime, and another treatment, slightly above the local practice i.e., irrigation once in 14 days was given, with an object, to find out, whether irrigation frequencies can be slightly extended, on their own or with the aid of some mulches. To find out the ability of mulches in conserving moisture, and to assess whether irrigation can be reduced substantially by its application, a third treatment, which a very wide frequency i.e., irrigation once in 21 days was also included to form the three major treatments.

Mulching tried:

Hoeing with hand hoe to loosen the soil and to form a dust mulch as they dry on, was done two days after irrigation. Chopped sugarcane trash at 3 tons/acre was applied evenly in between the cholam rows to form the trash mulch. Black polythene film (100 guage) 14.5 inches wide, obtained from Messrs Union Carbide Company (Pte) Ltd., was spread in the cholam rows and weighed down to the soil by pressing soil at both ends. No intercultivation but hand weeding formed the control.

The treatments were denoted by the following symbols:

Irrigation frequencies:-

I_1 - Irrigation once every seven days

I_2 - Irrigation once every fourteen days

I_3 - Irrigation once every twentyone days

Mulches:-

M_1 - No cultivation but hand weeding (control)

M_2 - Soil or dust mulch

M_3 - Trash mulch

M_4 - Polythene mulch

Method of application:

All the plots irrespective of the treatments, received the same irrigation water till the 24th day after sowing, when first weeding, thinning and gap filling was done. The mulches were applied three days after.

Thereafter the plots received controlled irrigation as per schedule, except during periods of heavy rainfall, so as to get 3 acre inches of water at a time. The quantity of irrigation water was determined by placing a right angled 'V' notch calibrated as per the formula of Roe (1950) at the head of irrigation channel. Care was taken to wet the entire distributory channels before water was let into the plots.

Soil physical characters studied:

(1) Soil moisture:- Soil moisture determinations were made by the gravimetric method by taking soil samples from the 0-9" depth two days after each irrigation and one day prior to the next irrigation.

(2) Soil temperature:- Soil temperatures were recorded at 8 A.M. and 2 P.M. During a short period soil temperature

were recorded at 6, 8 and 10 A.M., 12 Noon and 2, 4 and 6 P.M. to study the variations in the soil temperature. The measurements were confined to the top 3 inches layer only.

(3) Soil nitrogen:- Soil analysis for nitrogen and other major nutrients were done at the beginning and at the close of the experiment to assess the nitrogen variations in the soil.

(4) Weed growth:- As mulches influence weed growth an assessment of weed growth in the different treatments was considered necessary. Fresh weight of weeds removed at each weeding was taken for this purpose.

Plant characterisation studied:

Many workers have reported relationship of some plant characteristics to yield of crops. Hence the following observations were made:

(1) Height of plants:- Positive correlation between plant height and crop yields were reported by Kottur and Chavan (1927; 1928) and Venkataraman and Subramanyan (1933) in cholam. To study the aforesaid relationship, two measurements, one on the 60th day after sowing and another on the 90th day were taken. The height of the plants were taken from the first node at the base to the height of the youngest leaf or to the tip of the panicle, as the case may be.

(2) Number of leaves and leaf area:- The essentiality of leaves and the influence of leaf area at the time of grain

filling in wheat was observed by Mosolov and Panova (1953) and Watson and French (1961). The number of leaves per plant were counted on the 60th and 90th day. Also the length of leaves and the maximum width were taken out and the leaf area was calculated according to the formula suggested by Stickler <u>et. al</u>. (1961).

(3) Length of earhead:- Harper <u>et. al</u>. (1931) and Venkataraman and Subramanyam (1933) found a positive correlation between the length of earhead and yield in cholam. Hence, this character was included in the study. The length of earheads were measured from the base of the lowest branching of the rachis from the peduncle to the tip of the panicle as a whole.

(4) Breadth of earhead:- The maximum breadth of the earhead was measured by placing it in between two wooden blocks and by adjusting them, so that they touched the periphery of the earhead, and the inside measurement of the blocks were recorded on a meter scale. This data was collected since Patel and Patel (1927, 1928) and Ayyangar <u>et. al</u>. (1935) found a positive correlation between this characteristic and yield in cholam.

(5) Diameter of the peduncle:- Venkataraman and Subramanyan (1933) and Ayyangar <u>et. al</u>. (1935) found, diameter of the peduncle in cholam related to grain yield. In the present study the thickness or diameter of the peduncle at

a standard distance of 5 cms., below the base of the panicles was measured with a vernier caliper.

(6) Root studies:- The effect of root system on plant growth is well known. The root system was carefully extracted and their number and dry weight were recorded for the studies.

Yield characteristics like grain yield, straw yield and dry matter production were observed. For all studies 15 plants were selected at random, and were tagged at the beginning of the experiment.

CHAPTER IV

EXPERIMENTAL RESULTS

The various observations made during the course of this experiment, and the yield of grain and straw were statistically analysed. Analysis of variance (vide appendix) indicated that differences between different frequencies of irrigations were not statistically significant in regard to certain characters like plant height, length of earhead, grain and straw yield etc., at the two higher moisture regimes, while the lower moisture regime was inferior in many respects. In most cases different types of mulches gave highly significant differences except in the case of root characteristics and leaf measurements.

The results are furnished below:

1. Height of plants:-

A. Influence of moisture regime: The mean plant height recorded at 90 days after sowing is furnished in Table I.

Table I

Treatments	Mean height of plants (in cms)	S.E.	C.D. (P=0.05)
I_1 (irrigation once in 7 days)	174.34		
I_2 (irrigation once in 14 days)	175.37	0.84	2.43
I_3 (irrigation once in 21 days)	154.50		

Conclusions: $\underline{I_2, I_1}, I_3$

Plant height in fortnightly and weekly irrigation treatments were on a par, and significantly superior to that under irrigation once in 21 days.

B. Influence of mulching: The different types of mulches had no influence on plant height. The mean measurements are given in appendix XIV.

2. Number of leaves per plant:-

A. Influence of moisture regime: The mean number of leaves recorded are furnished in appendix XV. There was no difference between the treatments.

B. Influence of mulches: There was no significant difference between no mulch and mulch treatments. The data is furnished in appendixXVI.

3. Total leaf area per plant:-

A. Influence of moisture regime: Different moisture regime due to frequencies of irrigationshad no effect on the total leaf area per plant. The measurements are given in appendix XVII.

B. Influence of mulching: The different types of mulches did not exhibit any influence on the leaf area per plant. Appendix XVIII furnishes the mean leaf area per plant.

4. Number of roots per plant:-

A. Influence of moisture regime: The mean number of roots per plant observed under different moist ure regimes are furnished in appendix XIX. There was no significant differences between the different moisture regimes.

B. Influence of mulching: The differences between the treatments were not significant. The measurement on different mulches are given in appendix XX.

5. Weight of roots per plant:-

A. Influence of moisture regime: Among the moisture regimes the differences of one over the other, on the weight of roots per plant, were not significant (vide appendix XXI).

B. Influence of mulching: There were no significant differences between the different types of mulches (vide appendix XXII).

6. Length of earhead:-

A. Influence of moisture regime: The mean length of earheads recorded under the various moisture regimes due to irrigation frequencies are given in Table II.

Table II

Treatments	Mean height of earhead (in cms)	S.E.	C.D. (P=0.05)
I_1	10.34		
I_2	10.25	0.11	0.31
I_3	9.85		

Conclusions: $\underline{I_1, I_2}, I_3$

The higher two moisture regimes have registered

Significantly longer earheads than the lowest moisture regime. Between irrigations once in seven days and 14 days the difference was not pronounced.

B. Influence of mulching: The length of earheads as affected by the different types of mulches are furnished in table III.

Table III

Treatments	Mean length of earhead (in cms)	S.E.	C.D. (P=0.05)
M_1	9.80		
M_2	10.33	0.09	0.26
M_3	10.20		
M_4	10.26		

Conclusions:
<u>M_2, M_4, M_3, M_1</u>

Application of mulches have significantly increased the length of earheads, but among the mulches, there were no difference.

7. <u>Breadth of earhead</u>:-

A. Influence of moisture regime: There were no significant difference between the treatments (vide appendix XXIII).

B. Influence of mulching: Table IV gives the mean breadth of earhead, as affected by the different mulch treatments.

Table IV

Treatments	Mean breadth of earhead (in cms)	S.E.	C.D. (P=0.05)
M_1	4.05		
M_2	4.33	0.063	0.180
M_3	4.08		
M_4	4.23		

Conclusions: $\overline{M_2, M_4}, \underline{M_4, M_3, M_1}$

While soil mulch was significantly superior to trash and no mulch, polythene mulch was on a par with it. Polythene, trash and no mulch treatments showed no differences.

C. Interaction: The interaction between irrigation treatments and mulches on the mean breadth of earheads are shown below:

Table V

Breadth of earheads (in cms) Sub plot	Main plot I_1	I_2	I_3
M_1	4.26	4.14	3.77
M_2	4.39	4.44	4.18
M_3	3.89	4.05	4.28
M_4	4.24	4.37	4.10

S.E. 0.110 C.D. 0.314

Conclusions:

(1)

Mulches	Moisture regime
M_1	I_1, I_2, I_3
M_2	I_2, I_1, I_3
M_3	I_3, I_2, I_1
M_4	I_2, I_1, I_3

(2)

Moisture regimes	Mulches
I_1	M_2, M_1, M_4, M_3
I_2	M_2, M_4, M_1, M_3
I_3	M_3, M_2, M_4, M_1

With polythene and soil mulch, the three irrigation frequencies were on a par, and with no mulch the higher two moisture regimes were significantly superior to the lowest moisture regime though between them there was no difference. With trash mulch, however, the interaction differed, and the lowest moisture regime was superior then the highest, though the medium regime was on a par with both.

At the highest and lowest moisture regime, trash mulch and no mulch respectively, were significantly inferior to others, which were on a par. With fortnightly irrigations, however, soil and polythene mulch were significantly superior to trash, while no mulch was on par with all others.

8. <u>Diameter of Peduncle</u>:-

A. Influence of moisture regime: The difference were not significant. Moisture regime had no influence on the diameter of peduncle (vide appendix XXIV).

B. Influence of mulching: In table VI below the mean diameter of peduncle observed under different mulch treatments are given.

Table VI

Treatment	Mean diameter of Peduncle (in cms)	S.E.	C.D. (P=0.05)
M_1	0.863		
M_2	0.946	0.011	0.031
M_3	0.925		
M_4	0.927		

Conclusions: $\underline{M_2, M_4, M_3}, M_1$

Application of mulches had significantly increased the diameter of peduncle, but among the mulches there were no difference.

9. <u>Grain yield</u>:-

A. Influence of moisture regime: Table VII indicates the mean yield of grain per plot registered by the various irrigation treatments.

Table VII

Treatments	Mean grain yield per plot (in gms)	S.E.	C.D. (P=0.05)
I1	61.42		
I2	61.00	1.41	4.44
I3	54.67		

Conclusions: $\underline{I_1, I_2}, I_3$

The closer two irrigation frequencies of seven days and 14 days were on a par, and have recorded significantly increased yields over the wider irrigation frequency viz., irrigation once in 21 days.

B. Influence of mulching: The mean grain yield recorded with the various types of mulches are furnished in table VIII.

Table VIII

Treatments	Mean grain yield per plot (in gms)	S.E.	C.D. (P=0.05)
M_1	52.22		
M_2	66.22	1.40	3.99
M_3	57.11		
M_4	60.56		

Conclusions: M_2, M_4, M_3, M_1

All the mulches have registered significantly increased yield over no mulch. Among the mulches, soil mulch was significantly superior, to the other two and polythene mulch significantly superior to trash.

10. Straw yields:-

A. Influence of moisture regime: The straw yield per plot obtained with the different moisture regimes are furnished in the table below: (Table IX)

Table IX

Treatments	Mean straw yield per plot (in kgs)	S.E.	C.D. (P=0.05)
I_1	37.65		
I_2	39.15	1.49	4.25
I_3	33.36		

Conclusions: I_2, I_1, I_3

The two closer frequencies of irrigation were on a par and significantly superior to the wider frequency of irrigation.

B. Influence of mulching: Table X indicates the mean straw yield recorded with the various types of mulches.

Table X

Treatment	Mean straw yield per plot (in kgs)	S.E.	C.D. (P=0.05)
M_1	33.17		
M_2	41.71	1.17	3.34
M_3	34.89		
M_4	37.13		

Conclusions: M_2, M_4, M_3, M_1

While soil mulch and polythene mulch were significantly superior to no mulch, trash mulch is on a par with no mulch. Again polythene and trash mulch are on a par while soil mulch is superior to all other treatments.

11. Weed infestation and influence of mulching:-

Table XI furnishes the weight of fresh weeds registered under the different mulches tried.

Table XI

Treatments	Mean weight of fresh weeds per plot (in kgs)	S.E.	C.D. (P=0.05)
M_1	16.16		
M_2	7.54	0.33	0.93
M_3	10.43		
M_4	12.35		

Conclusions: M_1, M_4, M_3, M_2

Differences between mulches in the matter of weed growth under them were pronounced and significant. Soil mulch was the most efficient followed by trash and polythene mulches.

12. Economics:-

The yield of grain and straw per acre with different treatment combinations were worked out and their value estimated at 0.36 nP and 0.05 nP respectively per kilogram. Table XII furnishes the details.

Profit or loss over control (per acre)

Treatments		Value of produce	Rating	Difference over control	Cost of treatment over control (Control Rs.71.63nP)	Profit or loss over control
		Rs.nP		Rs.nP	Rs.nP	Rs.nP
I_1 -	M_1	305.31	100	--	--	--
	M_2	375.05	123	+69.74	+21.25	+48.49
	M_3	311.19	102	+ 5.91	+13.66	- 7.79
	M_4	353.71	116	+48.39	+498.97	-450.58
I_2 -	M_1	323.25	106	+17.93	-21.04	+38.98
	M_2	374.75	123	+69.43	+ 0.20	+69.23
	M_3	330.97	108	+25.66	- 7.39	+33.04
	M_4	347.13	114	+41.82	+484.82	-443.40
I_3	M_1	247.99	81	-57.20	-31.57	-25.76
	M_2	354.66	116	+49.34	-10.32	+59.66
	M_3	288.72	95	-16.59	-17.91	+ 1.32
	M_4	295.86	97	+ 9.45	+467.41	+457.96

It is clear from the foregoing table that the treatment combination I_2M_2 (irrigation once every 14 days and dust mulching) has given the maximum profit per acre.

CHAPTER V

DISCUSSION AND CONCLUSIONS

The present investigation was taken up to study as to what extent the soil moisture supply can be reduced without causing decline in yield and the possibility of limiting the loss of moisture through evaporation using different types of mulches. A popular, high fertility, high yielding cholem strain Co.18, was selected for the study.

Field experiments were laid out during 1962 summer season in the Central Farm, Coimbatore, with three frequencies of irrigation and four types of mulch treatments. The plant characters which contribute directly or indirectly to the yield were also studied to find out how far they were influenced by the varying soil physical conditions.

The data were analysed statistically. Indications are that the moisture regimes and the mulches have a positive influence on a good number of plant characters and yield of grain and straw. The inter-action effect, however, did not come out as significant in the case of majority of characters studied.

PLANT CHARACTERS

1. Height of plants:

Influence of moisture regime - The height of plants are positively influenced by moisture regime due to different irrigation frequencies, though the differences between the two higher moisture regimes were not significant (Table I). It is possible that the water supply under the two higher moisture regimes might have been more near to the requirements of the crop, and at the lower moisture regime plants have suffered scarcity and consequently cell division and cell ~~enlargement~~ elongation might have been reduced resulting in decreased growth at that moisture regime. One of the first effect of water deficit is a decrease or cessation of elongation of stems and this process is dependent on the turgid conditions of the cell (Heyns, 1940; Broyer, 1950; Burstrom, 1956; Cleland and Bonner 1956).

Influence of mulching - The mulches tried have in no way influenced plant height. It is probable that the lower temperature fluctuation under mulch might have neutralised the effect of a higher moisture

2. Number of leaves per plant:

Influence of moisture regime - The varying moisture regime had no effect on the number of leaves per plant. Within limits, the number of leaves produced per plant may be dependent on factors other than moisture.

Influence of mulching - Mulches too had no influence on the mean number of leaves per plant. The variations in soil temperature and soil moisture depletion under mulches are in effect opposite to each other and the possible response of the crop on the matter of the number of leaves produced might have been mullified by this conflicting effect.

3. Total leaf area per plant:

Influence of moisture regime - The total leaf area per plant was not related to the soil moisture regime. This finding is in contrast to that of Watson (1947, 1956) and Wadleigh and Gauch (1948). This deviation from the general trend reported by many workers may be due to the fact that the range of moisture content simulated in this experiment might have been not enough to adversly affect the leaf area, or other factors like the critical stages of plant growth, which would have had influence on the leaf area, might have interfered, mullyfying possible response.

Influence of mulches - Leaf area was independent of the influence of mulches. Many workers have associated higher crop yields to higher leaf area. Yet the fact that the influence of mulches was not felt on the leaf area, leaves the significant difference in yields to the possibility of variation in photosynthetic efficiency per unit leaf area.

4. Number of roots per plant:

Influence of moisture regime - The effect of various moisture regime was not felt on the number of root per plant. As an inverse relationship exist between soil moisture content and aeration as suggested by Raney (1949) and Taylor (1949) the insufficiency of oxygen which is essential for root growth and aerobic respiration, might have limited root growth at the higher two moisture regimes.

Influence of mulching - The effect of mulching too, was not felt on the number of roots per plant. The counter balancing nature of the prominent physical characteristics under the mulches viz., soil temperature and moisture depletion may be the reason for this apparent nonresponse.

5. Weight of roots per plant:

Influence of moisture regime - Mean weight of roots per plant was not different under the different moist regimes.

Influence of mulching - The apparent uniformity in weight of roots follows the trend observed in the matter of mean number of root produced per plant.

Despite the fact that the root systems were uniform in many respects, variations in other yield attributes and yield of grain and straw were observed. Extension of root to dry soil from a moist area, and utilization of moisture from that zone was shown to be real by Hunter and Kelly (1946), but at the same time they were shown to be inefficient in absorbing radio active phosphorous from the dry soil, and the fact that, equally developed root system under low moisture regime could not give the same effect to the plant in many yield attribute, and yield, may be due to the fact that they were unable to utilize the essential plant nutrients in the dry soil.

6. Length of earhead:

Influence of moisture regime - Mean length of earhead (Table II) under the two higher levels of moisture was significantly superior to the low moisture regime. This finding is in consonence with the general trend and the higher moisture utilization and nutrient uptake under the higher moisture regime might have been instrumental in registering the longer earheads.

Influence of mulching - Though variation in soil temperature and moisture content were not much different under no mulch and soil mulch, and the same were widely varying from that of trash and polythene mulches, and yet the fact that the earhead length recorded under the 3 mulches was significantly superior over no mulch (Table III) shows factors other than soil temperature and moisture under the mulch are responsible for the variation. Difference in weed growth, which was much pronounced, and better nutrient availability and resultant utilization may be the reason for this behaviour. This is in conformity with the finding of Knake and Slife (1962).

7. Breadth of earhead:

Influence of moisture regime - It was interesting to note that the moisture regime had no influence on the breadth of earheads though its length was affected by it. It is possible that the increase in the yield of grain due to the moisture regime had not resulted in a similar increase in the breadth of the earhead.

Influence of mulching - The effect of the different types of mulches on the breadth of earhead is in keeping uniformity with most other characters (Table IV). Increase in the breadth is in the order as is found with length of earhead and also grain and straw yield. Soil mulch had the most pronounced effect and was significantly superior to trash and no mulch though on a par with polythene mulching. More than the factors like soil temperature and moisture, the weed growth and consequent nutrient variation in the upper layer of soil might have influenced this value. Knake and Slife (1962) have pointed out the profound influence of weed growth on the earhead characteristics in Maize. Vittum, Peck and Carruth (1959) too had observed the effect of moisture variations on the earhead characteristics in maize.

Interactions of mulches and moisture regimes - The interaction of moisture regimes and mulching are presented in Table V. From the table it can be seen that with soil and polythene mulches, there was no significant difference between moisture regimes due to irrigation frequencies. With no mulch, the two higher moisture regimes were significantly superior. This could be due to higher moisture content prevailing with the closer two irrigation frequencies and the too low a moisture regime due to the combined effect of a wide irrigation frequency and higher evaporation losses under a bare soil surface in the other treatment. With trash mulch, however, the wider irrigation frequency, was significantly superior to the closest frequency, the medium one being on a par with both. A very high resultant moisture regime due to the closest irrigation frequency and comparatively cooler soil atmosphere might have been instrumental in the lower values in the closer irrigation frequency with trash mulch.

8. Diameter of peduncle:

Influence of moisture regime - The diameter of the peduncle was not influenced by moisture regime. But a careful observation had revealed that the higher moisture regime had resulted in an increase in the diameter of the peduncle from 0.892 cms to 0.928 cms., though the difference were not significant.

Influence of mulching - Though the response in diamter of the peduncle to the mulches were on a par, all of them were significantly superior to no mulch (Table VI). This is in line with the effect on grain yield recorded and indicates its relationship with diameter of peduncle. Better weed control and consequent nutrient availability and uptake might have been the factors that influenced this most.

9. Grain yield:

Influence of moisture regime - It can be observed from the data that variation in soil moisture regimes had significantly varied the yield of grain in cholam (Table VII).

As regards the various moisture regimes tried, the highest moisture regime due to closest frequency of irrigation had given the maximum yield followed by medium and low moisture regimes, though there was no significant difference between the high and medium moisture regimes. But the low moisture regime due to very wide irrigation frequency had resulted in low yield and the other two treatments were significantly superior to it. Thus the yield of grain decreased with increasing soil moisture stress. The percentage of yield compared to high moisture regime, were 99.3% with medium, and 89% with the low moisture regimes. It is clear from this that cholam cannot withstand severe moisture stress conditions beyond that created by irrigation frequencies of 14 days, without serious reduction in yield. This trend was observed in several crops previously and is in line with the findings of Brown and Shrader (1959) and Music and Grimes (1961).

From the results obtained it can be seen that the medium moisture regime due to irrigation once in 14 days gave equally good yields as that obtained with double the number of irrigations in the high moisture regime.

The increase in yields due to the moisture regimes may be due to the cumulative effect of growth and yield attributes. It was found by earlier workers that a positive correlation exists between yield of grain and height of plants (Patel, 1923; Kottur and Chavan, 1927, 1928; Venkataraman & Subramanyan 1933; Krishnamoorthy, 1962). It is significant here, that response in plant height to moisture regimes was also significant, being higher at the high and medium levels of moisture and the yield of grain too was in the same way influenced.

Length of earhead is another factor that has shown similar response in this experiment. Harper et al. (1931) and Rengaswamy Ayyengar et al. (1955) have found correlation between the length of earhead and yield of cholam. The influence of moisture regime on the length of earhead was also similar in that, the high and medium moisture regimes had given significantly longer earheads and its influence was felt on the grain yield.

In many other instances like the number of roots per plant, the mean weight of roots per plant, breadth of earhead and diameter of peduncle the same trend was not observed.

Influence of mulching - The influence of different types of mulches on the yield of grain is shown in Table VIII. It was of interest to note that the effect of mulches on the grain yield of cholam was highly significant. This shows that sorghum could utilise the benefits that accrue out of the mulch treatments in the matter of producing more grain. This is in consonance with the finding of Adams (1962) in Sorghum and Goczek (1959); Randhawa et al. (1960); Collings (1961); Robin et al. (1961) in other crops.

The different types of mulches had showed significant effect on the yield of grain, and had affected most other characteristics which are correlated with yield. Yield characteristics

istics like length of earheads, breadth of earheads, diameter of peduncle, were all influenced by the mulching treatments. Environmental conditions like soil moisture regime, soil temperature fluctuations, and above all the weed competition was intimately influenced by the mulches.

At all moisture regimes, it was seen that the soil mulch had given the maximum yield. Influence of mulches on the yield characters that might have positively affected the grain yield was also of the same trend, though it was of no significance in the case of length of earhead and diameter of peduncle. The most significant reduction in weed competition might have been the factor most instrumental in registering the highest yield under soil mulch. High crop yield in weed free treatment had been reported by Aspinall (1960); Nieto (1960); Khan and Mathur (1961); Knake and Slife (1962). The sparse weed growth might have left more nutrients in the soil for the crop to utilize for its grain production. Temperature fluctuations too was of the highest order under soil mulch and notwithstanding the fact that, moisture content was adversely affected, had resulted in better growth and higher yield. It is to be remembered that subsequent irrigations might have nullified the adverse effect of the moisture stress, as reported by Birch (1960) and Orchard (1961) and have resulted in increased yields due to the more availability of nutrients on rewetting.

Yield of grain under polythene mulch was significantly superior to that under no mulch and trash mulching and was lower than the yields obtained with dust mulch. This is not in conformity with the findings of Vlcek (1961) and Clarkson (1960). The yield characteristics under all treatments were closly trailing behind that of soil mulch though they were of no significance. Moisture conditions were altered in that higher moisture content in the top soil was recorded. However, soil temperature fluctuations were less. Weed growth was much intense, and the more serious nature of it can be conceived only when it is remembered that all of it were in the same root zone as that of the crop plant, and only this can account for the lower yields compared to dust mulch. The physical competition of weed roots and the nutrient demand at the very same absorption zone of the crop might have restricted the nutrient uptake of the crop and resulted in lower yields despite the better moisture conservation obtained under polythene mulch.

Grain yield under trash mulch was lower than that obtained with polythene and soil mulch, though it was significantly superior to no mulch. This finding in comparison with no mulch is in line with the findings of Collings (1961); Blunder (1954) and Bose (1954). Weed growth in trash mulched plots was less than that under polythene and moisture conservation and all soil temperature fluctuations were more or less same as under polythene, but the yield was significantly lower than that under polythene. This could be attributed only to the probable locking up of nitrogen for the decomposition of the mulch, the bulk of which was decomposed during the growing period. This view was expressed by Leake (1954); Bollen and Lu (1957); and Larson, Burows and Willis (1960) as the reason for lower yields under some trash mulches.

Severe weed competition combined with the maximum moisture depletion might have caused the lower yield in the no mulch plots.

While assessing the relative merits of the different treatments it can be seen that the higher two moisture regimes between them have not materially affected cholam yields, even though differences in quantity of water supplied was to the tune of about 100% over the other. What is of importance in this finding is that a medium moisture regime with irrigations once in 14 days is quite sufficient for higher cholam yields and any water that is used over and above it, is a waste and could be otherwise used. The benefit that accrue out of the practice of hoeing to create a dust mulch and weed removal is singularly outstanding, in its efficiency in increased crop production and also in its economy.

In general, it was found that, while there was no difference in grain yield between the high and medium soil moisture regimes, the low moisture regime had resulted in significant reduction in yield. All mulches tried had significantly influenced the grain yield.

Yield data under different treatment combinations (vide Appendix XII) shows that mulches had positively influenced grain yield, sufficient to alter the effect of moisture regime. It is interesting to note that soil, trash and polythene mulches with medium moisture regime and soil mulch in combination with the low moisture regime had not only maintained the same grain yield as obtained with the high moisture regime due to closer irrigation frequency, but registered substantial increase over it, and showed the possibility of widening the irrigation frequency drastically without any decrease in yield whatsoever.

10. Straw yields:

It was seen that the moisture regimes tried had significantly influenced straw yield, even though the two higher moisture regimes were equal (Table IX). Above the medium moisture regime due to irrigation once in 14 days, there was absolutely no benefit due to the increased moisture supply and in fact it had depressed it, though not significantly. Thus an irrigation frequency of 14 days seems to be optimum for the best production of straw.

It is interesting to note that the trend in straw yield is also in line with many other yield attributes. A correlation between the yield of grain and yield of straw in cholam was reported by Harper et. al., 1931 and Ayyangar et. al., 1935 and the same trend could be observed from this data also.

Mulches had evinced their influence on the straw yield also. As in the case of grain yield and many other yield characteristics the soil mulch had registered significantly higher straw yield than any other treatment. Favourable nutrient conditions and freedom from weed competition like other yield characters might have positively influenced straw yield too. Polythene and trash were on a par. No mulch have registered lowest straw yield though on a par with trash mulch.

Straw yield trends with different treatment combinations shows that irrigation once in 14 days was better than that in seven days, with all mulch treatments. The practice of soil mulching could be adopted with advantage, even when the irrigation frequency is as wide as 21 days, as that had recorded better yield than no mulch with closer irrigation frequency of 14 or even seven days.

11. <u>Mulches and weed competition</u>:

Studies on the effect of mulching on weed growth, as assessed from the fresh weight of weeds recorded under the treatments (Table XI), shows very interesting trends. As was expected and in line with all the previous works, viz., Robinson (1957); Mathur (1960); Anon (1961) to cite only a few, mulches, all of the types tried have suppressed weed growth considerably and the maximum weed growth was recorded under no mulch treatment. Non disturbance of the soil during the growth of the weeds, leaves the root system in tact, and the unobstructed receipt of sunlight, unlike in the mulched plots have contributed to the increased weed growth under no mulch treatments. Among the mulches, the significantly higher weed growth under polythene may look odd at first glance, while Andrews <u>et. al</u>. (1958)

had claimed perfect weed control under black polythene mulch. The fact remains that invariably in all such experiments a complete cover of the soil, barring the small holes cut for the emergence of the seedling, often wide spaced seedlings resulting in fewer number of such holes per unit area, do not permit any sunlight at all and the resultant weed control obviously would have been perfect. In a row crop like cholam, when the polythene is spread in bands, achieving only about 80% coverage, the inter space close to the crop rows do not inhibit weed growth, but on the contrary, the favourable moisture and soil temperature conditions might have favoured and hastened weed growth as is seen from the results obtained in this experiment.

More uniform coverage of soil with trash mulch and consequent unavailability of sunlight might have been the reason for the sparse growth of weed under trash mulch, compared to that under polythene.

The profound reduction of weed growth under dust mulch could be attributed to the physical destruction or at least serious damage to the root system of weeds at the time of hoeing to create the dust mulch. By the time the under ground portion of weeds recuperate and begin to put forth fresh vegetation it is again destroyed by the hoeing operation. The most efficient weed control obtained under dust mulch, which have also influenced yield and yield attributes of the crop, is the factor that emerges out as of prime importance, from all the mulch treatments.

12. Economics:

The cost of each treatment combinations and the value of the extra yield that was obtained were calculated and the profit or loss over control was worked out to study the economic feasibility of the treatments (Table XII). The highest gross value of produce was recorded in plots receiving weekly irrigations and dust mulch, closely followed by by plots receiving fortnightly irrigation with dust mulching and the difference was negligible being Rs.0.30 nP per acre. But, while the former recorded a profit of Rs.48.49 nP over control, the returns from the latter was as high as Rs.69.23 nP i.e., a difference of Rs.20.74 nP over the first one. It was of interest to note that even though dust mulch in combination with irrigation once in 21 days have given lower yield and lower gross value of produce, it was unique in that it gave a profit of Rs.59.66 nP over control, and was only next to dust mulch and irrigation once in 14 days.

CHAPTER VI

S U M M A R Y

An experiment was conducted to find out the relative efficiency of three different moisture regimes, due to irrigation frequencies, at seven, fourteen and twenty one days, and three types of mulching viz., dust, trash and polythene mulches. The modifying effect of the mulches on soil conditions and crop growth was studied, to assess whether irrigation requirements could be reduced without deterioration in yield.

The moisture regime had significantly increased the height of plants and length of earheads, while it had no influence on other yield attributes. Length of earhead, breadth of earhead and diameter of peduncle were significantly increased by the mulches.

Highest yield of straw and grain was obtained with soil mulching at medium and high moisture levels, they being on a par. The medium moisture regime was found best with all mulches, while the lowest moisture regime was inferior with no mulch and polythene mulch. With trash mulch however, the lowest yield was recorded at the high moisture regime.

The irrigation frequency of seven days did not materially increase the yield over that of 14 days, and was less profitable in view of the high water demand. A medium moisture regime due to an irrigation frequency of 14 days was found to be the optimum. Wider frequency, though resulted in lower yields, was of some economic significance, and would be useful in combination with dust mulch created by judicious periodical hoeing in areas of extreme water scarcity.

The practice of creating a dust mulch, though it does not help in moisture conservation as was believed, neverthless eliminated weed competition, encouraged wider soil temperature fluctuations, and resulted in better crop growth and higher yields in this study. The cost of creating a dust mulch was reasonable and proved profitable.

Trash mulching and polythene mulching did not compare well with soil mulch at any of the moisture regime tried, besides the cost of polythene film was prohibitive to be of any use in grain crops.

A medium moisture regime maintained by fortnightly irrigation with surface hoeing to create dust mulch was found to be the best agronomic practice for limiting water use and giving higher yields with most economic returns.

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APPENDICES.

APPENDIX I

Height of plants at 90 days — Analysis of Variance

Source	D.F.	S.S.	M.S.	F.
Replications	5	1181.14	236.23	
Main plot treatments	2	6643.01	3321.51	199.01**
Error (1)	10	766.86	16.69	
Sub plot treatment	3	54.68	18.23	
Main plot x sub plot	6	542.96	90.49	1.62
Error (2)	45	2509.51	55.77	
Total	71	11698.16		

APPENDIX II

Number of leaves per plant — Analysis of Variance

Source	D.F.	S.S.	M.S.	F.
Replications	5	4.19	0.84	
Mainplot treatments	2	2.15	1.13	2.46
Error (1)	10	4.63	0.46	
Sub plot treatments	3	1.23	0.41	1.95
Main plot x Sub plot	6	0.93	0.16	
Error (2)	45	9.23	0.21	
Total	71	22.36		

* Significant at P = 0.05 level

** Significant at P = 0.01 level

APPENDIX III

Leaf area per plant — Analysis of Variance

Source	D.F.	S.S.	M.S.	F.
Replications	5	502475.97	100494.99	
Main plot treatments	2	11578.54	5789.27	
Error (1)	10	2127422.25	212742.23	
Sub plot treatments	3	320445.19	106815.06	2.76
Main plot x sub plot	6	148956.26	24826.04	
Error (2)	45	1738575.07	38635.00	
Total	71	4849452.28		

APPENDIX IV

Number of roots per plant — Analysis of Variance

Source	D.F.	S.S.	M.S.	F.
Replications	5	2063.86	412.77	
Main plot treatments	2	41.69	20.85	
Error (1)	10	1633.96	163.39	
Sub plot treatments	3	263.53	87.84	2.13
Main plot x sub plot	6	188.58	31.43	
Error (2)	45	1851.88	41.15	
Total	71	6043.46		

APPENDIX V

Weight of roots per plant — Analysis of Variance

Source	D.F.	S.S.	M.S.	F.
Replications	5	198.96	39.79	
Main plot treatments	2	4.48	2.24	
Error (1)	10	54.06	5.41	
Sub plot treatments	3	15.19	5.06	1.17
Main plot x Sub plot	6	58.60	9.77	2.26
Error (2)	45	194.61	4.32	
Total	71	525.90		

APPENDIX VI

Length of earhead — Analysis of Variance

Source	D.F.	S.S.	M.S.	F.
Replications	5	4.71	0.94	
Main plot treatments	2	3.34	1.67	5.76*
Error (1)	10	2.86	0.29	
Sub plot treatments	3	2.99	1.00	6.25**
Main plot x sub plot	6	1.18	0.20	1.25
Error (2)	45	7.19	0.16	
Total	71	22.27		

APPENDIX VII

Breadth of earhead — Analysis of Variance

Source	D.F.	S.S.	M.S.	F.
Replications	5	3.6269	0.7254	
Main plot treatments	2	0.3496	0.1748	1.10
Error (1)	10	1.5960	0 1596	
Sub plot treatments	3	0.9545	0.3182	4.40**
Main plot x sub plot	6	1.3398	0.2233	3.09*
Error (2)	45	3.2536	0.0723	
Total	71	11.1204		

APPENDIX VIII

Diameter of peduncle — Analysis of Variance

Source	D.F.	S.S.	M.S.	F.
Replications	5	0.0967	0.0193	
Main plot treatments	2	0.0160	0.0080	2.96
Error (1)	10	0.0265	0.0027	
Sub plot treatments	3	0.0892	0.0297	14.14**
Main plot x sub plot	6	0.0238	0.0040	1.90
Error (2)	45	0.0954	0.0021	
Total	71	0.3476		

APPENDIX IX

GRAIN YIELD — ANALYSIS OF VARIANCE

Source	D.F.	S.S.	M.S.	F.
Replications	5	465.27	93.05	
Main plot treatments	2	686.77	343.39	7.20*
Error (1)	10	476.90	47.69	
Sub plot treatments	3	1873.50	624.50	17.59**
Main plot x sub plot	6	398.00	66.33	1.87
Error (2)	45	1597.50	35.50	
Total	71	5497.94		

APPENDIX X

STRAW YIELD — ANALYSIS OF VARIANCE

Source	D.F.	S.S.	M.S.	F.
Replications	5	1951.83	390.37	
Main plot treatments	2	433.32	216.66	4.14*
Error (1)	10	523.48	52.35	
Sub plot treatments	3	738.06	246.02	10.01**
Main plot x sub plot	6	94.53	15.76	
Error (2)	45	1106.32	24.58	
Total	71	4847.54		

APPENDIX XI

Fresh weight of weeds — Analysis of Variance

Source	D.F.	S.S.	M.S.	F.
Replications	5	8.70	1.74	
Main plot treatments	2	1634.26	817.13	833.81**
Error (1)	10	9.75	0.98	
Sub plot treatments	3	1084.70	361.57	188.32*
Main plot x sub plot	6	159.78	26.63	13.87*
Error (2)	45	86.43	1.92	
Total	71	2983.62		

APPENDIX XII

Grain yield in kilograms per acre

Irrigation frequency/ Mulches	I_1	I_2	I_3	Mean
M_1	221.8	203.5	167.0	197.4
M_2	259.0	255.8	236.3	250.3
M_3	208.6	224.9	214.2	215.9
M_4	239.5	238.2	209.2	228.9
Mean	232.2	230.6	206.7	

APPENDIX XIII

Straw yield in kilogram per acre

Irrigation frequency/ Mulches	I_1	I_2	I_3	Mean
M_1	4510	5000	3758	4422
M_2	5637	5653	5392	5561
M_3	4722	5000	4232	4651
M_4	5213	5228	4411	4951
Mean	5020	5220	4448	

APPENDIX XIV

Mean plant height as influenced by mulches

Treatments	Mean plant height (in cm)
M_1	166.85
M_2	167.78
M_3	168.42
M_4	169.23

APPENDIX XV

Mean number of leaves as influenced by moisture regime

Treatments	Mean number of leaves per plant
I_1	6.395
I_2	6.714
I_3	6.795

APPENDIX XVI

Mean number of leaves as influenced by mulches

Treatments	Mean number of leaves per plant
M_1	6.594
M_2	6.853
M_3	6.585
M_4	6.590

APPENDIX XVII

Leaf area per plant as influenced by moisture regime

Treatments	Mean leaf area per plant(in sq.cms)
I_1	1834.543
I_2	1856.438
I_3	1864.572

APPENDIX XVIII

Leaf area per plant as influenced by mulches

Treatments	Mean leaf area per plant(in sq.cms)
M_1	1756.987
M_2	1944.947
M_3	1844.647
M_4	1860.796

APPENDIX XIX

Number of roots per plant as influenced by moisture regime

Treatments	Mean number of roots per plant
I_1	44.86
I_2	44.10
I_3	43.01

APPENDIX XX

Number of roots per plant as influenced by mulches

Treatments	Mean number of roots per plant
M_1	42.29
M_2	42.98
M_3	47.22
M_4	43.46

APPENDIX XXI

Weight of roots per plant as influenced by moisture regime

Treatments	Mean weight of roots per plant(in gms)
I_1	13.60
I_2	13.75
I_3	13.16

APPENDIX XXII

Weight of roots per plant as influenced by mulches

Treatments	Mean weight of roots per plant(in gms)
M_1	12.84
M_2	13.77
M_3	14.08
M_4	13.37

APPENDIX XXIII

Breadth of earhead as influenced by moisture regimes

Treatments	Mean breadth of earheads (in cms)
I_1	4.19
I_2	4.25
I_3	4.08

APPENDIX XXIV

Diameter of peduncle as influenced by moisture regimes

Treatments	Mean diameter of peduncle (in cms)
I_1	0.928
I_2	0.917
I_3	0.892

APPENDIX XXV

Analysis data of the soil:

A. Mechanical analysis:

Coarse sand	36.8 per cent
Fine sand	19.6 "
Silt	9.9 "
Clay	28.3 "

B. Pore space 62.0 "

C. Percolation rate 6.8 c.c/hour

D. Moisture constants:

Hygroscopic coefficient	4.58 per cent
Water holding capacity	61.40 "
Moisture equivalent	37.00 "

E. Nutrients:

Nitrogen	0.034	per cent
Total phosphoric acid	0.060	"
Available phosphoric acid	0.0238	"
Total potash	0.606	"
Available potash	0.531	"

APPENDIX XXVI

Moisture fluctuations - Treatment war (per cent on moisture free basis)

Serial No.	Treatments	Two days after irrigation	One day prior to irrigation
1.	I_1 M_1	25.08	13.06
2.	" M_2	25.13	14.88
3.	" M_3	24.96	15.56
4.	" M_4	25.06	16.07
5.	I_2 M_1	24.61	9.32
6.	" M_2	25.32	10.04
7.	" M_3	23.92	11.87
8.	" M_4	24.40	11.90
9.	I_3 M_1	24.31	7.09
10.	" M_2	25.04	7.83
11.	" M_3	24.81	10.56
12.	" M_4	24.26	10.65

APPENDIX XXVII

Temperature fluctuations under the mulches (on 18.5.1962)

Treatment	8 AM	10 AM	12 Noon	2 PM	4 PM	6 PM
M_1	26.75	30.5	34.0	36.9	32.5	29.50
M_2	27.50	33.0	36.0	38.5	34.0	29.50
M_3	26.50	29.5	30.5	34.5	30.0	28.75
M_4	27.00	31.5	32.5	35.0	31.0	30.50

APPENDIX XXVIII

Temperature fluctuations under mulches (Average for "8 AM and 2 PM")

Treatment	8 AM	2 PM
M_1	28.1	37.9
M_2	28.7	38.5
M_3	27.7	35.0
M_4	27.4	35.8

APPENDIX XXIX

Data of water received by the crop (in inches)

Source	I_1	I_2	I_3
Irrigations prior to laying of mulches	13	13	13
Irrigation after laying of mulches	33	18	9
Rainfall	6.14	6.14	6.14
Total	52.14	37.14	28.14

I L L U S T R A T I O N S

PLATE I

Effect of treatments on the yield of grain

I_1 Irrigation once in seven days

I_2 Irrigation once in fourteen days

I_3 Irrigation once in twentyone days

M_1 No mulch (control)

M_2 Soil mulch

M_3 Trash mulch

M_4 Polythene mulch

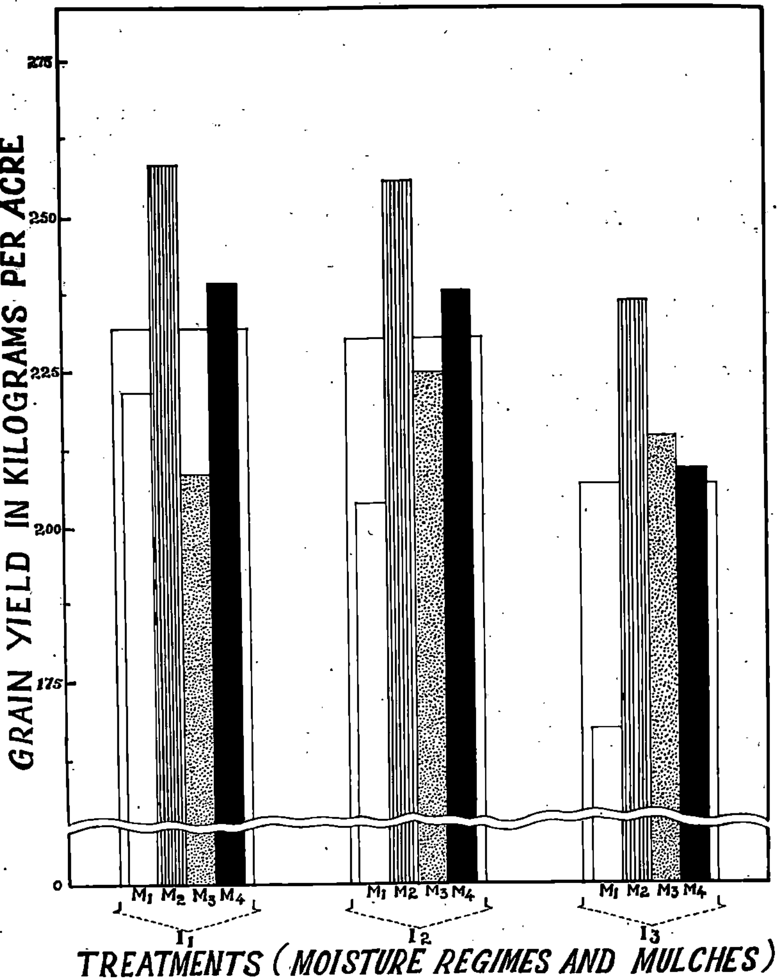

GRAIN YIELD IN KILOGRAMS PER ACRE
275
250
225
200
175
0
M1 M2 M3 M4
I1
M1 M2 M3 M4
I2
M1 M2 M3 M4
I3
TREATMENTS (MOISTURE REGIMES AND MULCHES)

PLATE II

Effect of treatments on the yield of straw

I_1 Irrigation once in seven days

I_2 Irrigation once in fourteen days

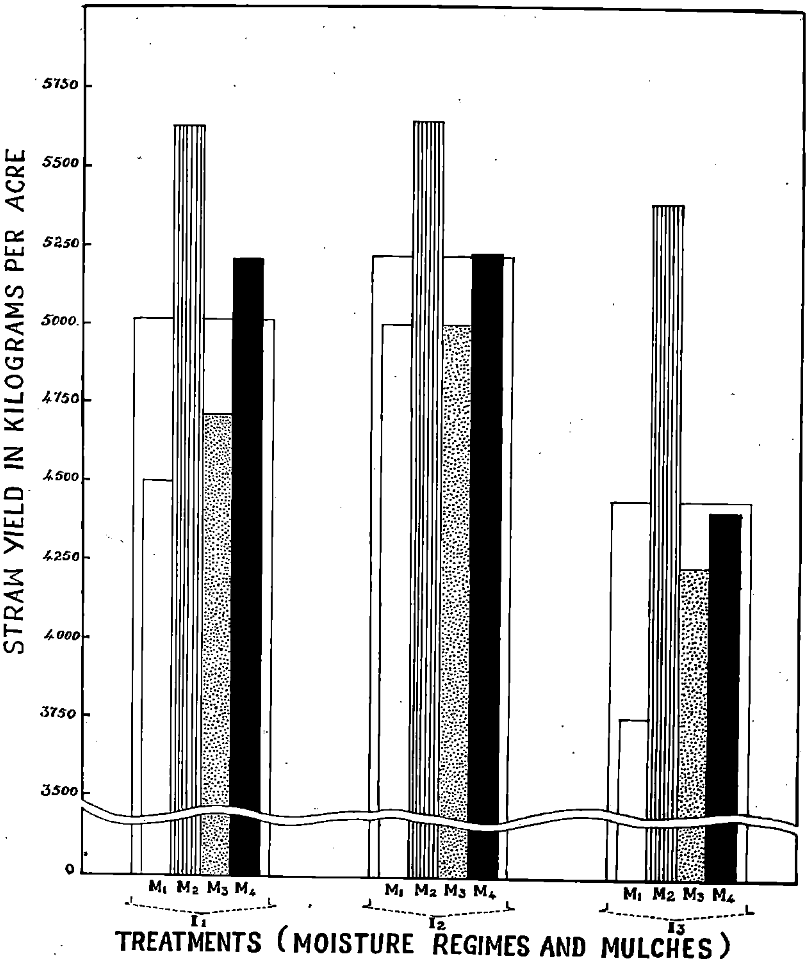
I_3 Irrigation once in twentyone days

M_1 No mulch (control)

M_2 Soil mulch

M_3 Trash mulch

M_4 Polythene mulch



STRAW YIELD IN KILOGRAMS PER ACRE
5750
5500
5250
5000
4750
4500
4250
4000
3750
3500
0
M1 M2 M3 M4
I1
M1 M2 M3 M4
I2
M1 M2 M3 M4
I3
TREATMENTS (MOISTURE REGIMES AND MULCHES)

PLATE III

Comparison between the values of the produce

I_1 Irrigation once in seven days

I_2 Irrigation once in fourteen days

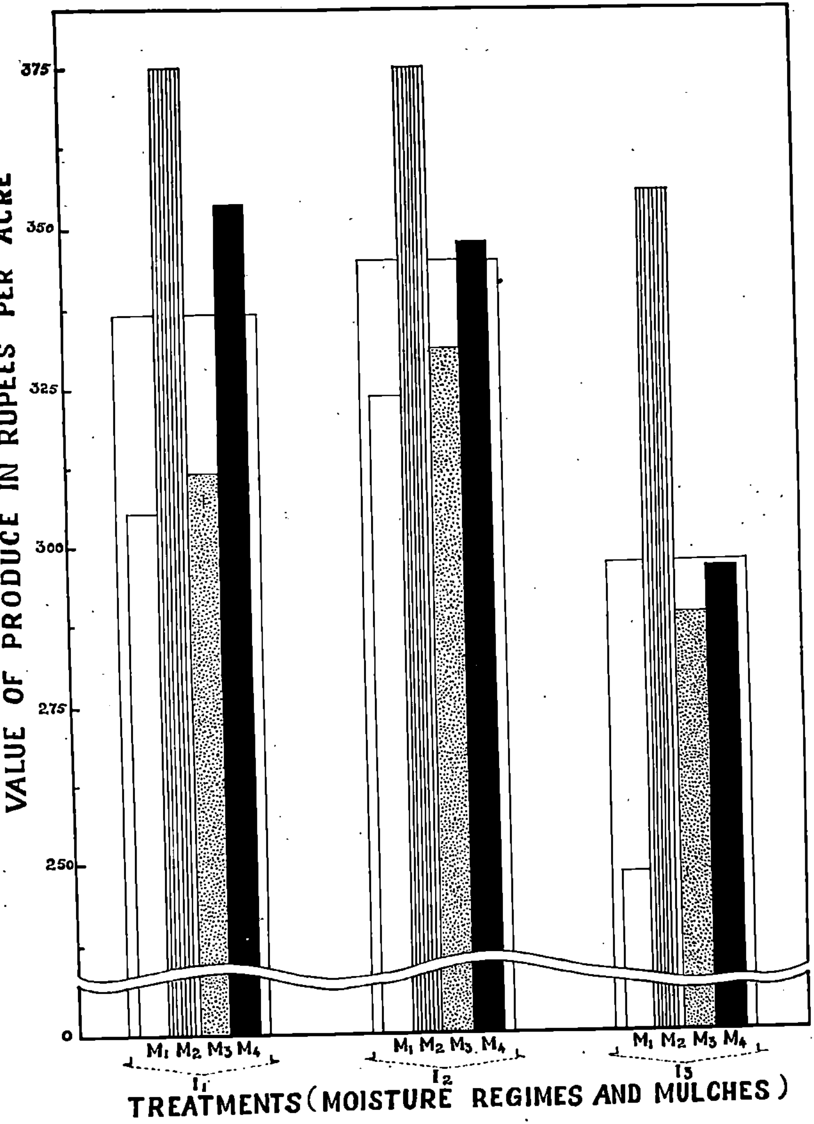
I_3 Irrigation once in twentyone days

M_1 No mulch (control)

M_2 Soil mulch

M_3 Trash mulch

M_4 Polythene mulch



VALUE OF PRODUCE IN RUPEES PER ACRE
375
350
325
300
275
250
0
M1 M2 M3 M4
I1
M1 M2 M3 M4
I2
M1 M2 M3 M4
I3
TREATMENTS (MOISTURE REGIMES AND MULCHES)

PLATE IV

Comparison of cost of treatments over common cultivation expenses

I_1 Irrigation once in seven days

I_2 Irrigation once in fourteen days

I_3 Irrigation once in twentyone days

M_1 No mulch (control)

M_2 Soil mulch

M_3 Trash mulch

M_4 Polythene mulch

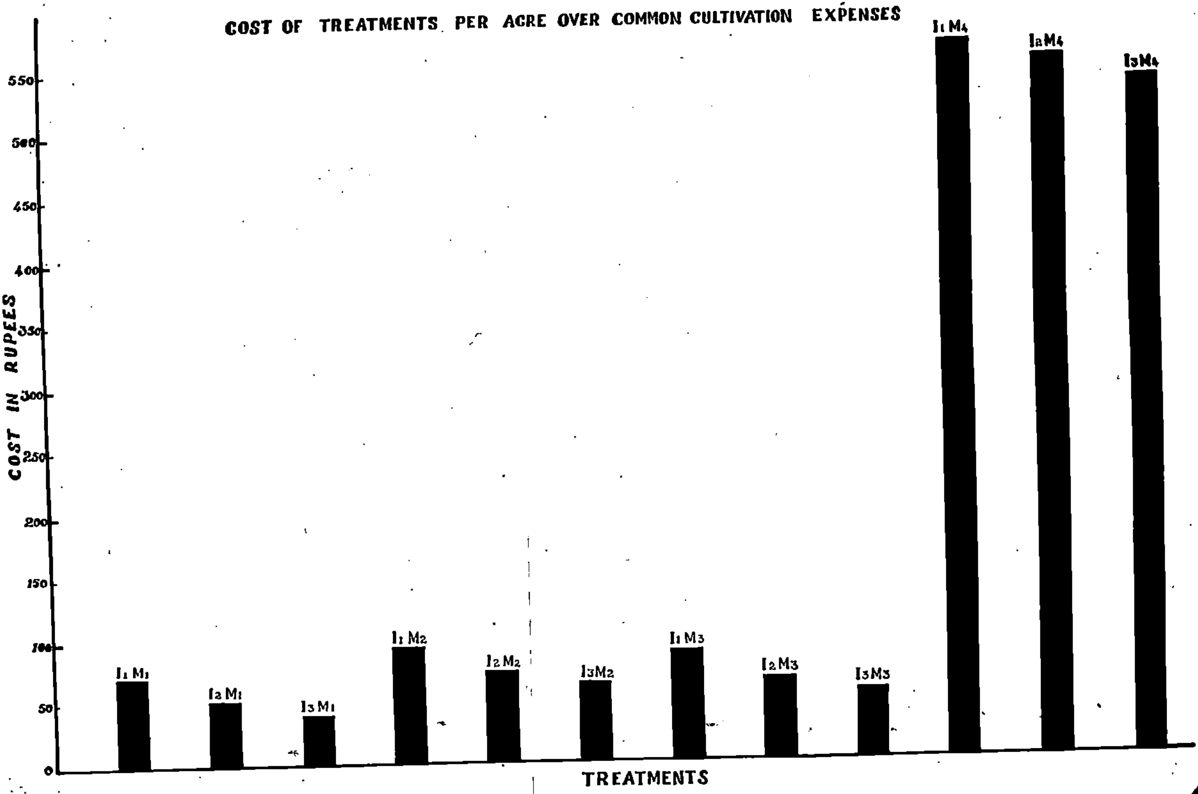

COST OF TREATMENTS PER ACRE OVER COMMON CULTIVATION EXPENSES
COST IN RUPEES
550
500
450
400
350
300
250
200
150
100
50
0
I1 M1
I2 M1
I3 M1
I1 M2
I2 M2
I3 M2
I1 M3
I2 M3
I3 M3
I1 M4
I2 M4
I3 M4
TREATMENTS

PLATE V

Economics of treatments

I_1 Irrigation once in seven days

I_2 Irrigation once in fourteen days

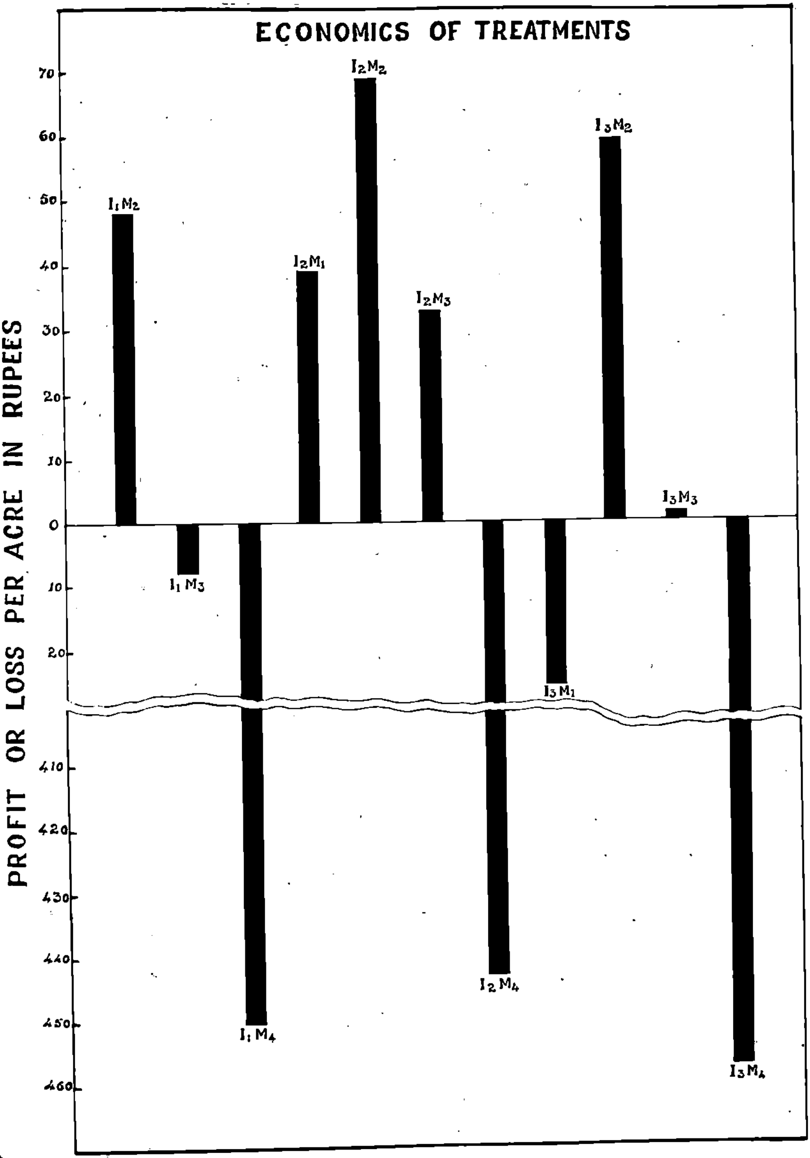
I_3 Irrigation once in twentyone days

M_1 No mulch (control)

M_2 Soil mulch

M_3 Trash mulch

M_4 Polythene mulch



ECONOMICS OF TREATMENTS
PROFIT OR LOSS PER ACRE IN RUPEES
70
60
50
40
30
20
10
0
10
20
410
420
430
440
450
460
I1 M2
I1 M3
I1 M4
I2 M1
I2 M2
I2 M3
I2 M4
I3 M1
I3 M2
I3 M3
I3 M4

PLATE VI

Effect of treatments on weed growth

I_1 Irrigation once in seven days

I_2 Irrigation once in fourteen days

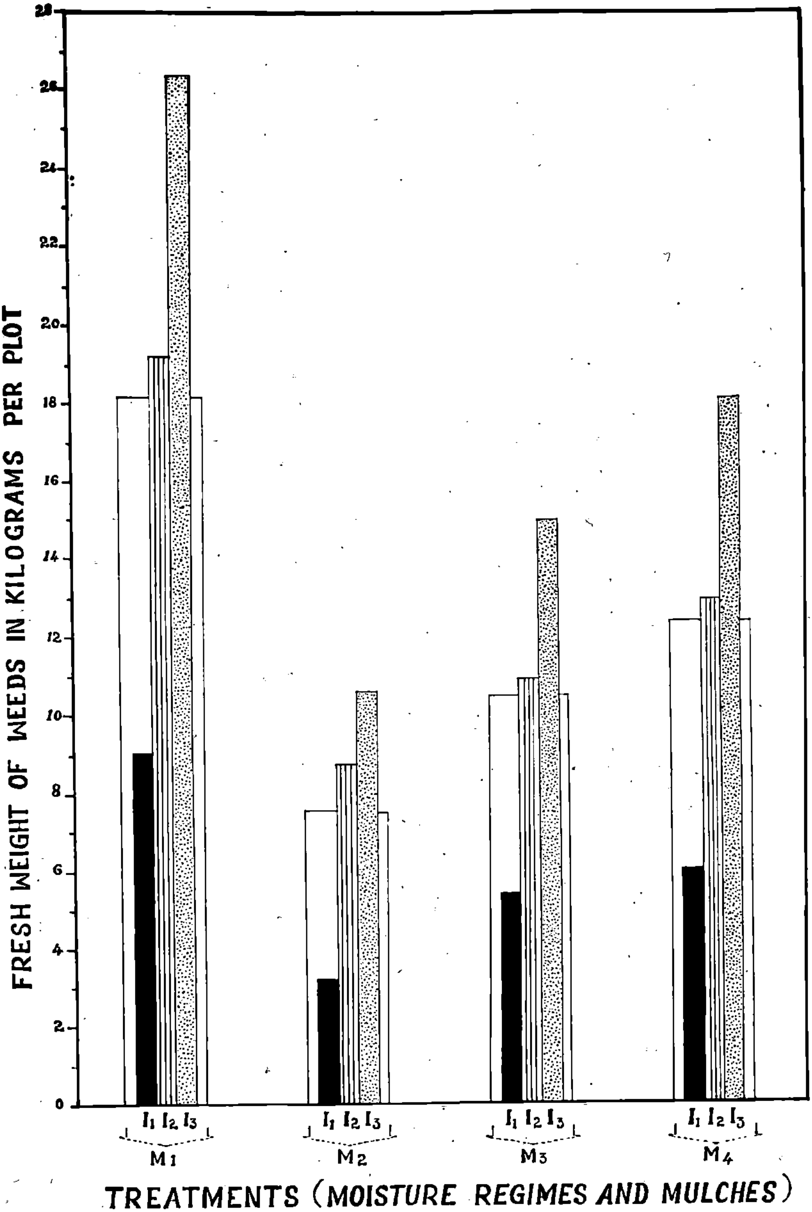
I_3 Irrigation in twentyone days

M_1 No mulch (control)

M_2 Soil mulch

M_3 Trash mulch

M_4 Polythene mulch


FRESH WEIGHT OF WEEDS IN KILOGRAMS PER PLOT
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
I1 I2 I3
M1
I1 I2 I3
M2
I1 I2 I3
M3
I1 I2 I3
M4
TREATMENTS (MOISTURE REGIMES AND MULCHES)