

“INFLUENCE OF DATE OF SOWING AND IRRIGATION SCHEDULING (IW:CPE RATIOS) ON GROWTH, YIELD ATTRIBUTES AND YIELD OF SUMMER MOTH BEAN (*Vigna acontifolia (jacq.) marechal*) UNDER MIDDLE GUJARAT CONDITIONS.”

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**OF
Master of Science
(AGRICULTURE)**

**IN
AGRONOMY**

**BY
MANRAJ YADAV**

B. Sc. (Agri.)

**DEPARTMENT OF AGRONOMY
B. A. COLLEGE OF AGRICULTURE
ANAND AGRICULTURAL UNIVERSITY
ANAND - 388110 (GUJARAT)**

2011

(Reg. No. 04-0963-2009)

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M.Sc. (Agri.)

AGRONOMY

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Abstracts

February) and D₄ (19th February) and four levels of irrigation scheduling (IW:CPE ratios) viz., I₀- (Control- irrigation at critical growth stages) at branching, at flowering, at pod formation and at grain formation, I₁ (0.5 IW: CPE ratio), I₂ (0.7 IW: CPE ratio) and I₃ (0.9 IW: CPE ratio) were tested under strip plot design with four replications.

The results indicated that treatment D₂ sowing at (30th January) recorded the highest plant height (10.00 cm, 19.50 cm and 27.05 cm at 30, 60 DAS and at harvest, respectively. While the lowest plant height (6.25 cm, 16.33 and 21.13 cm at 30, 60 DAS and at harvest, respectively) was observed under 20th January sowing (D₁).

Sowing of crop at 30th January (D₂) resulted into significantly minimum days to 50% flowering (29.25 days). The treatment D₄ (sowing at 19th February) significantly recorded the lowest days to maturity (81.44 days).

Treatment D₂ sowing at (30th January) recorded the significantly higher yield attributes viz., average number of pods per plant (37.81), average pod length (3.78 cm) and average number of seeds per pod (5.66).

Date of sowing had significant effect on seed and dry gotar yield of moth bean. Significantly the highest seed (460 kg/ha) and dry gotar yield (653 kg/ha) was recorded under treatment D₂ (sowing at 30th January). Whereas, significantly lower seed (368 kg/ha) and dry gotar yield (578 kg/ha) was under treatment D₁ (sowing at 20th

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January). Treatment D₂ (sowing at 30th January) increase seed yield to the tune of 18.26%, 19.78% and 20% over the treatments D₃ (sowing at 9th February), D₄ (sowing at 19th February) and D₁ (sowing at 20th January), respectively.

Significantly the highest test weight (19.20 g) was also observed under treatment D₂ (sowing at 30th January). The maximum mean consumptive use of water (408.5mm) and water use efficiency (1.170 Kg/ha-mm) was noticed under treatment D₂ (sowing at 30th January).

The highest gross and net realization (Rs. 34663 & 21725/ha) respectively, and CBR and net CBR 2.68 & 1.68, respectively was secured under treatment D₂ (sowing at 30th January).

Among the different levels of irrigation scheduling, application of irrigation at 0.7 IW:CPE ratio (I₂) recorded significantly higher average plant height (11.37, 19.76, 27.95 cm) at 30 and 60 DAS and at harvest, average length of pod (3.78 cm), average pods per plant (37.53) and average number of seeds per pod (5.66).

Treatment I₂ (0.7 IW:CPE ratio) secured significantly the highest seed (472 kg/ha) and dry gotar yield (664 kg/ha), whereas, significantly the lowest seed (319 kg/ha) and dry gotar yield (560 kg/ha) was observed under treatment I₀ (control, irrigation at critical growth stages). Treatment I₂ (0.7 IW:CPE ratio) increase seed yield at the extent of 16.73%, 17.58%, and 32.41% over the treatments I₁ (0.5 IW:CPE ratio), I₃ (0.9 IW:CPE ratio) and I₀ (control, irrigation at

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critical growth stages), respectively. The treatment I₂ (0.7 IW: CPE ratio) recorded higher test weight (20.90g) and harvest index (41.15%). The consumptive use of water was increased with increase in IW:CPE ratio resulted higher consumptive use of water under 0.9 IW:CPE ratio whereas, the water use efficiency was higher with lower IW:CPE ratio of 0.5.

The highest gross and net realization (Rs. 35566 & 18128/ha), CBR and net CBR (2.04 & 1.04) respectively, was secured under treatment I₂ (0.7 IW:CPE ratio).

During the course of investigation, interaction effect of date of sowing and irrigation scheduling (IW:CPE ratio) revealed that treatment combination of (D₂I₂), 30th January date of sowing of moth bean with irrigation scheduling based on IW:CPE ratio 0.7 (8+1 irrigation) recorded significantly the highest seed yield (651 kg/ha).

For securing higher seed yield and net realization from summer moth bean crop Cv. RMO-225 raised on loamy sand soil of middle Gujarat, it is advisable that crop should be sown at 30th January with nine irrigations, each of 50 mm depth scheduled at an IW:CPE ratio of 0.7. The common irrigation should be applied immediately after dry sowing, first irrigation at fourteen days after common irrigation and second at also fourteen days after first irrigation and remaining six irrigations should be applied at an interval of seven to ten days.

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CERTIFICATE

This is certify that the thesis entitled **“INFLUENCE OF DATE OF SOWING AND IRRIGATION SCHEDULING (IW: CPE RATIOS) ON GROWTH, YIELD ATTRIBUTES AND YIELD OF SUMMER MOTH BEAN (*vigna acontifolia Jacq. Merechal*) UNDER MIDDLE GUJARAT CONDITIONS.”** submitted by **MANRAJ YADAV Reg. No. 04-0963-2009** in partial fulfillment of the requirements for the award of the degree of **MASTER OF SCIENCE (AGRICULTURE)** in **AGRONOMY** of the Anand Agricultural University is a record of bonafide research work carried out by him under my personal guidance and supervision. The thesis has not previously formed the basis for award of any degree, diploma or other similar title.

Place : Anand

(J.J. PATEL)

Date : / /2011

Major

Guide

**B. A. College of Agriculture
A.A.U., Anand-388 110**

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Towards the end of this endeavour it's my honour to extol my insight etiquette to all those who have directly or indirectly me to complete this task.

Everything has its own beauty, but not everyone can see without critical observation and great vision.

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Place: Anand

Date: / /2011.

Yadav)

(Manraj

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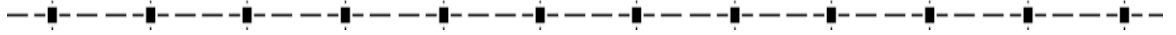
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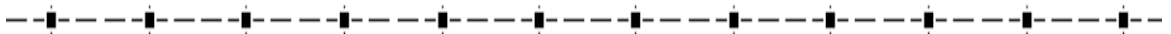
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LIST OF ABBREVIATION AND SYMBOLS



AAU	Anand Agricultural University
Anon.	Anonymous
B. C.	Before christ
B. D.	Bulk density
C. D.	Critical difference
C. V.	Coefficient of variation
Cv.	Cultiver
CBR	Cost benefit ratio
cm	Centimeter
CPE	Cumulative pan evaporation
CUW	Consumptive use of water
cv.	Cultivar
DAP	Diammonium phosphate
DAS	Days after sowing
E	East
EC	Electrical conductivity
<i>et al</i>	et allii and other
etc.	Etcetera
F. C.	Field capacity
Fig.	Figure
g.	Gram
g/cc	Gram per cubic centimeter

GAU	Gujarat Agricultural University
ha.	Hectare
hr.	Hour
I	Irrigation
i.e.	That is
IARI	Indian Agricultural Research Institute
ICBR	Incremental cost benefit ratio
IW	Irrigation water
K	Potash
Kg.	Kilogram
kg/ha	Kilogram per hectare
kg/ha-mm	Kilogram per hectare millimeter
L	Labour
LAI	Leaf area index
M	Man
m	Meter
Max.	Maximum
Min.	Minimum
mm.	Millimeter
N	Nitrogen
N	North
No.	Number
NS	Non-significant
°C	Degree Celsius
P	Phosphorus

PB	Pair of bullock
PE	Pan Evaporation
pH	Potential of hydrogen ion
PWP	Permanent wilting point
q	Quintal
Rs.	Rupees
S. Em.	Standard error of mean
S. K. Nagar	Sardar Krushinagar
spp.	Species
Sr.	Serial number
T	Tonne
T. N.	Tamil Nadu
U. P.	Utter Pradesh
USWB	United State Weather Bureau
var.	Varity
viz.	Namely
W. B.	West Bengal
WUE	Water use efficiency
WEE	Water expense efficiency
%	Per cent
@	At the rate of

INTRODUCTION

In India, the pulses are very important source of protein for human diet; Pulses are rich in protein, ranging from 17-27 per cent. Moth bean is a good source of protein 24% and are high in dietary fibers. As more than 80 % of our population is vegetarian. However, the production of pulses is not keeping pace with the growing population of the country. Our crop improvement goals are based on the promise that the good health of the soils and human population is one of the most important requisite to build up a modern society. Pulses hold a unique position in every system of the Indian farming, as a main crop, catch crop, cover crop, green manure crop and intercrop.

India is largest producer of pulses in the world with 25 percent share in global production. In India, the pulses grown over an area of 23.63 million hectares with an annual production of 14.59 million tones and average productivity of 625 kg per hectare (Anon, 2010). While, Gujarat occupies an area of 8.32 lakh hectare With an annual production 5.73 lakh tone and average productivity of 582 kg per hectare (Anon, 2010). Pulses have built in capacity of fixing the atmospheric nitrogen through their root nodules with the help of rhizobia. It provides protein rich diet to human being, nutritious fodder to animal and also as mulch to the soil, even though, the area and production of pulses is not up to the mark.

Introduction

Moth bean [*Vigna acontifolia* (Jacq.) Marechal] is indigenous to the Indian subcontinent. It is mentioned in the *Taitriya Brahmana*, a commentary on the Yajurveda during (7000BC). There are two Sanskrit names *makushta* or *makushtaka*, and *vanamudga* (literally meaning “wild green gram”). Names in most Indian languages today are derived from these two Sanskrit names, except the distinct Tamil name, *narippayir*. The name “moth bean” is coined from the Hindi name *moth*. Kautilya during (321–296 BC).

Moth bean [*Vigna acontifolia* (Jacq.) Marechal] is an important underutilized pulse crop. It belongs to family *legumenacea* and subfamily *papilionaceae*. It is known by several vernacular names like Kidney bean because the shape of seed is just like kidney of human being, Dew bean, math, madike, bhioni, kunkuma, matki etc. in different linguistic zones of India.

Moth bean (*Vigna acontifolia* (Jacq.) Marechal) originated in the semi arid regions of India, most probably in the State of Rajasthan (Fageria, 1992). It is cultivated in the states of Rajasthan, Haryana, Uttar Pradesh, Punjab, Maharashtra, and Gujarat.

Watt (1889) described it as a drought resistant crop of the entire Indian subcontinent including the mountains up to 1200 meter. The most common sowing practice was through broadcast. In Punjab, it was cultivated with black and green grams as a mixed crop, more often in the unfertile soils. Sometimes it was grown in fertile soils and intercropped with pearl millet. It was grown as a sole crop in Uttar Pradesh, and it was widely cultivated in the Meerut

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region. The Dholpur region of Rajasthan had a very large area under moth bean. The plant resembles a small mat. It is a ground-hugging plant and only about a one foot high. The densely matted branches, which grow horizontally and have deeply notched leaflets on long leaf branches, are somewhat similar to the leaves of certain varieties of sweet potatoes. The crop is generally grown in the north Western deserts regions of India and Pakistan, especially in area where moong bean greatly suffers from drought. Production of moth bean varies in the India, and all production is consumed within the country.

Moth bean grain as a feed for fattening oxen and horses. Moth bean was not given to cattle as it prevented the flow of milk and also documented the narcotic property of moth bean roots. Lawrence (1996) mentioned moth bean as a feed for sheep in Kashmir. Bhavaprakash (1997) mentions the medicinal uses of moth bean, especially in reducing fever, as well as the narcotic property of its roots (Chunekar and Pandey, 1998).

It is a minor *kharif* pluses crop and considered as one of the most drought tolerant among the grain legumes. Moth bean flour blended @ 10, 15, 20, and 25% in whole wheat flour for the production of biscuits to improve the quantity and quality of protein, mineral content and fiber. In India, green pods are eaten as a vegetable, and the tiny seeds are eaten as a whole or split. A favourite

Indian method of preparation is to fry and mathia preparation for

Introduction

during diwali festival in whole Gujarat.

In India it is cultivated in an area of 0.89 million hectares, mostly confined to Rajasthan, Maharashtra, Karnataka, Gujarat, and Haryana, with a production of 0.5 million tones (Anon., 2010). Rajasthan alone accounts for more than 80% of the total area and about 55% production of the country. In Gujarat, it is cultivated in the districts of Banaskantha, Kutch, and Surendranager, some part of Vadodara, and Jasdan taluka of Amreli. During the year of 2010 moth bean seed requirement in Gujarat is 15300 quintals but availability only 5759 quintals seeds (Anon.,2010).

The lower productivity of this crop is attributed to several factors. Growing under moisture stress conditions, marginal lands with very low inputs and without pest and disease management, non availability of high yielding varieties and late sowing. Moreover, the yield of local cultivars of moth bean is much less as compared to other pulse crops. Hence, there is need to enhance the production potential of this crop through use of organic manures, biofertilizers. Chemical fertilizers play an important role to meet the nutrient requirement of the crop but continuous use of these on lands will have deleterious effects on physical chemical and biological properties of soil, which in turn reflects on yield (Sarkar *et al.*, 1992).

Date of Sowing has been recognized as the most important non monetary input affecting yield of *summer* moth bean as late sowing coincides with high temperature during the initial crop growth stage and pre- monsoon shower at reproductive stage. On

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the other hand, early sown crop faces moderate temperature during initial growth stage, particularly in middle Gujarat region, which adversely affect the crop growth and finally the yield. Late sowing dose not provide enough time to prepare land for *kharif* crop, which delays *kharif* sowing. Therefore, it is imperative to determine the optimum time of sowing of moth bean crop for obtaining higher economic yield.

Water is well known essential constituent of living organism for their growth and development. Both excess or deficit use of water, reduces the crop yield drastically. Water stress during the active crop growth phase results into cessation of growth as it influences the photosynthesis and other physiochemical processes and or death, by desiccation. The excess water leads to the problems of raising water table, soil salinity. Hence, water management studies have become an important aspect of research for irrigated crops. Irrigation is mainly given to crop for achieving maximum yield with batter quality of produce. The ideal scheduling of irrigation depends upon the soil, climate and plant characteristics.

The climatic factors play an important role in deciding the water need of crops and the criteria of soil water regime for scheduling irrigation can not be considered without taking into account the climatic factor. Dastane (1972) suggested the concept of irrigation scheduling based on IW: CPE ratios. In this method, pan evaporation from an open pan evaporimeter is used to estimate the amount of water given by the ratio of irrigation water (IW) to

Introduction

cumulative pan evaporation (CPE). The evaporation per day is taking into consideration. The basic requirement of this approach is to find out the permissible soil water depletion before irrigation is applied to various crops.

Moth bean variety RMO-225 is recently released and recommended for *summer* cultivation in Rajasthan, Maharashtra, and Gujarat region. Literatures relating to the combined effect of date of sowing and irrigation scheduling based on IW: CPE ratios on growth, yield attributes and yield of *summer* moth bean under middle Gujarat condition is almost scarce.

Keeping all these factors in view, the present research work entitled **“Influence of date of sowing and irrigation scheduling (IW:CPE ratios) on growth, yield attributes and yield of summer moth bean (*vigna acontifolia* (jacq.) *Marechal*) under middle Gujarat conditions.”** Was undertaken during *summer* season of the year 2010, at College Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand, Gujarat, with the following objectives.

Objectives

- 1.** To study the influence of dates of sowing on growth, yield attributes and yield of summer moth bean
- 2.** To study the influence of irrigation scheduling based on IW: CPE ratios on growth, yield attributes and yield of *summer* moth bean.

Introduction

3. To study the interaction effect between date of sowing and irrigation scheduling (IW:CPE ratios)

REVIEW OF LITERATURE

The production potential of any crop depends on a number of interacting factors such as cultural practices, date of sowing, irrigation, spacing, fertilizer, insect-pest, disease control, water management, and weather condition. An attempt to review the literature pertaining to present investigation entitled “Influence of date of sowing and irrigation scheduling (IW:CPE ratio) on growth, yield attributes and yield of summer moth bean (*vigna acontifolia jacq. Marechal*) under middle Gujarat conditions”. Limited research works have been carried out earlier on these aspects. Hence, the research works done by the eminent scientists in India and abroad on these aspects of same family and same growth habit crops reviews in particular and in general are summarised here under with following heads:-

2.1 Influence of date of sowing

2.2 Influence of Irrigation schedules (IW: CPE ratio)

2.3 Interaction effect of date of sowing and irrigation scheduling

2.1 Influence of date of sowing

2.1.1 Influence of date of sowing on plant population and growth parameters

Chotaliya (1998) at Pulse Research Station, Modal farm, GAU, Vadodra, (Gujarat) conducted a field experiment on loamy sand soil during summer season of the year 1996 on green gram variety GM-3. He suggested that the different sowing dates had non significant

Review of literature

effect on initial and final plant stand of green gram.

Hussain *et al.* (2004) conducted an experiment during summer season of the year 2002 at Peshawer, (Pakistan) to study the effect of sowing dates (15th April, 15th May, 15th June) on green gram. The result indicated that green gram crop sown on 15th April, 15th showed maximum plant height as compared to other sowing dates.

2.1.2 Influence of date of sowing on yield attributes

A field experiment was conducted using five different sowing dates (1st, 10th, 20th, and 30th, March and 9th April) on sandy loam soil by Gupta and Lal (1989) at Central Potato Research Station, Modipuram (UP) during summer season of the year 1985 and 1986 on black gram cv. T-9. They observed that there were non significant difference in test weight of 1000 seeds due to different sowing dates.

Borah (1997) conducted an experiment at Shillongani, Assam in the year 1992 to study the yield variation in Summer green gram with respect to days to flowering in different dates of sowing i.e. 17th February, 27th February, 9th March and 19th March. The result revealed that the higher number of pods/plant was recorded to rest of the sowing dates.

Chotaliya (1998) indicated that the 1st March sowing significantly resulted into earlier flowering of green gram as compared to 15th March, but it was remained at par with 15th

Review of literature

February sowing.

Chovatia *et al.* (1993) found that the 2nd March sowing recorded significantly higher average number of seeds/pod of green gram as compared with other sowing dates.

2.1.3 Influence of date of sowing on yield

Chovatia *et al* (1993) conducted a field experiment with four different dates of sowing (31st January, 15th February, 2nd and 17th March) on green gram cv. K-851 during the *summer* season of the year 1989 on clay soil at pulse Research Farm, Gujarat Agricultural University, Navsari, (Gujarat). They observed that the crop sown on 2nd March recorded significantly higher grain yield compared with that when crop was sown on 31st January and 17th March.

At Regional Agricultural Research Station, Assam Agricultural university, Shillongani (Assam) during the year 1992, a field experiment was conducted by Borah (1997) with four different sowing dates, viz; 17th and 27th February and 9th and 19th March. The results indicated that the best period of sowing summer green gram was identified between 27th February and 9th March. Maximum grain yield obtained during this period to other sowing dates.

An investigation was carried out at Pulse Research Station, Model Farm, GAU, Vadodara, conducted a field experiment on loamy sand soil during summer of the year 1996 on green gram variety GM-3. The results revealed that among the different sowing dates i.e. 15th February, 1st and 15th March, crop sown on 1st March

Review of literature

significantly increased grain yield as compared to other sowing dates (Chotaliya 1998).

Dhanjal *et al* (2000) conducted an experiment on sandy loam soil at J.V. College, CCS University, Baraut (Uttar Pradesh), Green gram was sown on three different dates (15th March, 31st March and 16th April). They observed that the early sown (15th March) had higher grain yield as compared to later dates of sowing (31st March and 16th April).

An investigation was carried out by Patel *et al.* (2004) at Main Pulse Research Station, GAU, Sardarkrushinager (Gujarat) on sandy loam soil to evaluate the response of *summer* mung bean cv. GM-3 to different dates of sowing, (15th February, 1st and 15th March). They found that maximum yield of mung bean recorded when it was sown on 1st March as compared to early date of sowing.

2.1.3 Influence of date of sowing on economics

Patel *et al.* (2004) showed that among different sowing dates higher net realization of Rs. 9510/ha was secured under 2nd March sowing as compared to 15th February and 15th March sowing.

2.2 Influence of Irrigation scheduling (IW:CPE ratio)

2.2.1 Effect of Irrigation scheduling on growth parameters

A field experiment was conducted during summer season of the year 1989 at Instructional farm, Gujarat Agricultural University, Junagadh, (Gujarat) to study water and nutrient management of summer cowpea. Results revealed that the plant height and plant

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spread were recorded under IW: CPE ratio of 0.8 that was significantly higher over rest of the lower ratio of 0.6 and 0.4 (Kher *et al.* 1994).

Dabhi *et al.*, (1998) an investigation was conducted on deep black clayey soil at N. M. College of Agriculture, Gujarat Agricultural University, Navsari, (Gujarat) during summer season of the year 1992-93 and 1993-94. They found that application of irrigation at 0.75 IW: CPE ratio to green gram recorded appreciably higher plant height (43.5 cm and 58.1 cm), number of primary branches per plant (2.15 and 2.35) and number of leaves per plant (23.1 and 27.7) than other irrigation treatments.

Patel and Saraf (1999) conducted a field experiment on summer cowpea during the year 1986-87 at the Indian Agricultural Research Institute, (New Delhi) to study the effect of irrigation, phosphorous and weed control on growth and yield of cowpea. They observed that under 0.7 IW: CPE ratio recorded significantly taller plants, higher av. number of branches and nodules per plant than IW: CPE ratio of 0.5 and 0.3 respectively.

From the results of an experiment conducted at College Farm, Annamalai University, Annamalai Nagar (Tamil Nadu) on clay loam soil during summer season of the year 1998. Kavita and Wahab (2000) noticed that scheduling irrigation at 0.8 IW: CPE ratio significantly increased the growth parameters of greengram such as plant height, leaf area index, DMP and nodule number per plant being at par with 0.6 IW: CPE ratio during both the season.

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Prajapati *et al.*, (2007), conducted an experiment in sandy loam soils at college Agronomy Farm, B.A. college of Agriculture, Anand Agricultural University, Anand (Gujarat) during summer season of the year 2003 on influence of irrigation and plant growth regulator on summer green gram. They found that irrigation at 0.8 IW: CPE ratio recorded the highest plant height and LAI than 0.6 and 0.4 IW: CPE ratios.

A field experiment was conducted at Main Pulses Research Station, Gujarat Agricultural University, Sardarkrushinagar, (Gujarat) to study the response of summer clusterbean to irrigation based on cumulative pan evaporation ratio under varying doses of fertilizers. They reported that irrigation at 0.8 IW: CPE ratio recorded the highest plant height than 0.6 and 0.4 IW:CPE ratios.(Patel *et al.*, 2007).

Patel (2008), conducted an experiment on sandy loam soils at college Agronomy Farm, B.A. college of Agriculture Anand Agricultural University, Anand (Gujarat) during summer season of the year 2007 on influence of irrigation and growth regulator on summer cowpea. Results indicated that irrigation at 0.8 IW: CPE ratio recorded the highest plant height and LAI than 0.6 and 0.4 IW:CPE ratios.

2.2.2 Influence of Irrigation scheduling (IW:CPE ratio) on yield attributes and yield

Prasad and Yadav (1990) carried out field trials on silt-loam soil during summer season of the year 1987 and 1988 at college farm, Narendra Deva University of Agriculture and technology

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Faizabad, (U. P.). They reported that application of irrigation at an IW: CPE ratio of 0.8 produced significantly the highest biological as well as seed yield of green gram. Higher productivity of green gram was associated with higher number of pod, seed yield per plant test weight recorded under irrigation 0.8 IW: CPE ratio over 0.6 and 0.4 IW: CPE ratio respectively.

Tank *et al*, (1992) conducted a field experiment during the summer season of the year 1988 at Gujarat Agricultural University, Junagadh, (Gujarat), to study the response of 'K 851' summer green gram to irrigation. Results indicated that higher yield obtained under at 1.0 IW: CPE ratio resulted higher number of pod/plant, length of pod, test weight as well as seed yield than 0.8 and 0.6 IW: CPE ratio.

Kher *et al*, (1994) carried out a field experiment during summer season of the year 1989 at Instructional Farm, Gujarat Agricultural University, Junagadh (Gujarat). To study water and nutrient management of summer cowpea. Results revealed that higher seed yield (973 kg/ha) recorded under IW: CPE ratio of 0.8 which was significantly higher over rest of the lower ratios of 0.6 and 0.4 and also in yield parameters, such as number of seed/pod, length of pod and test weight.

An experiment was conducted on sandy clay loam soil of Mahatma Phule Krishi Vidyapith, Rahuri (Maharashtra) on summer mung bean during the year 1991. Pawar and Gathe (1994) found that the values of all the yield contributing characters viz number of pod, weight of grain per plant and thousand grain weight and grain

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yield were significantly higher under irrigation scheduled at 75 mm CPE than rest of the treatments.

Dabhi *et al*, (1998) carried out an investigation on deep black clayey soil at N. M. College of Agriculture, Gujarat Agriculture University, Navsari, (Gujarat), during summer season of the year 1992-93 and 1993-94. Results revealed that an application of irrigation at 0.75 IW: CPE ratio to green gram recorded significantly higher seed yield of 961, 1112 kg/ha and Stover yield of 1939, 3423 kg/ha both the year than 0.30, 0.45, 0.60 IW: CPE ratios, respectively.

Patel and Saraf (1999) conducted a field experiment on summer cowpea during the year 1986-87 at the Indian Agricultural Research Institute, New Delhi, (Delhi), to study the effect of irrigation, phosphorous and weed control on growth and yield of cowpea. Results indicated that 0.5 and 0.7 IW: CPE ratio recorded significantly higher number of pod/plant and seed/pod. As a result IW: CPE ratio of 0.7 produced significantly higher seed, haulm and fodder yield.

Results of an experiment conducted at pulse Research Farm, Gujarat Agricultural University, Navsari (Gujarat) during the summer season of the year 1992-93 and 1993-94 on deep black clayey soil, showed that irrigation at IW: CPE ratio of 0.75 recorded higher seed and stover yield of greengram as well as higher values of consumptive use of water (Dabhi *et al.*, 2000).

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Elamathi and Singh (2001) conducted an experiment at Tamil Nadu Agriculture University, Coimbatore, (T. N). During summer season of the year 1996 to study the effect of irrigation management on physiology and productivity of soybean. The result suggested that 0.6 IW: CPE ratio recorded significantly higher seed yield than the 0.4 IW: CPE ratio.

Kumar et al. (2002) evaluated the influence of irrigation schedules on seed yield, water use and water use efficiency of summer mungbean during summer season of year 1998, at Crop Research Farm, Haryana Agricultural University, Hisar, (Haryana) on sandy loam soil. The results revealed that the highest seed yield (1064 kg ha⁻¹) was recorded under three irrigations, one each at 20, 35 and 45 DAS than rest of the irrigation schedules.

Patel *et al*, (2005) conducted a field experiment at Gujarat Agricultural University, Sardar Krushinagar (Gujarat) during summer season of the year 1999 on well drained loamy soil. They observed that the scheduling of irrigation to cowpea at IW: CPE ratio of 1.0 increased seed yield at the extent of 25% as compared to that of 0.8 and 0.6 IW: CPE ratios, respectively. The yield reduction was observed due to moisture stress condition created during crop growth period.

Patel *et al*, (2005) conducted an experiment during summer season of the year 2001 at Instructional Farm, N. M. College of Agriculture, Navsari, Agriculture University, Navsari, (Gujarat). They

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found that more frequent irrigation at 0.9 IW: CPE ratio produced significantly the highest seed (1003.09 kg/ha) and haulm yield (2565.84 kg/ha) of summer black gram over 0.7 and 0.5 IW: CPE ratio.

Rana *et al*, (2005) conducted a field experiment to study the effect of irrigation schedules on the performance of summer black gram grown in association of sugarcane at Govind Ballabh Pant University of Agricultural and Technology, Pantnagar (Uttarakhand). According to result, irrigation applied at 1.2 IW: CPE ratio increased green pod yield to the tune of 8.1 and 14.1 % than 0.8 IW: CPE ratio and irrigation at flowering and pod filling stages, respectively.

Prajapati *et al*, (2007) conducted an experiment on sandy loam soils at college Agronomy Farm, B.A. college of agriculture, Anand Agriculture University, Anand (Gujarat), during summer season of the year 2003 to study the influence of irrigation and plant growth regulator on summer greengram. They found that irrigation at 0.8 IW: CPE ratio recorded the highest pod length, test weight and seed yield than 0.6 and 0.4 IW: CPE ratio.

A field experiment was conducted at Main Pulses Research Station, Gujarat Agricultural University, Sardarkrushinagar, (Gujarat) to study the response of summer clusterbean to irrigation scheduling based on cumulative pan evaporation ratio under varying doses of fertilizers. The results revealed that the highest seed yield (1238kg/ha) and straw yield (2848 kg/ha) recorded under

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0.8 IW: CPE ratio over 0.6 and 0.4 IW: CPE ratio (Patel *et al.*, 2007).

Patel (2008) conducted an experiment on sandy loam soils at college Agronomy Farm, B.A. college of Agriculture, Anand Agricultural University, Anand (Gujarat) during summer season of the year 2007 on influence of irrigation and growth regulator on summer cowpea. They found that irrigation at 0.8 IW: CPE ratio recorded the highest pod length and green pod yield (10053 kg/ha) than 0.6 and 0.4 IW: CPE ratio, respectively.

2.2.3 Effect of Irrigation schedules on consumptive use of water

Kher *et al.*, (1994) conducted a field experiment during summer season of the year 1989 at Instructional Farm, Gujarat Agricultural University, Junagadh, (Gujarat), to study water and nutrient management of summer cowpea. The scheduling irrigation based on IW: CPE ratio of 0.8 was significantly increased the consumptive use of water (221 mm) higher over rest of lower ratios of 0.6 and 0.4.

Pawar and Gathe (1994) conducted an experiment on sandy clay loam soil of Mahatma Phule Krishi Vidyapith, Rahuri, (Maharashtra) on summer moonbeam during the year 1991. Results indicated that the highest seasonal consumptive use of water was observed (560 mm) inclusive of effective rainfall when the irrigation were scheduled at 50 mm CPE, followed by 75 mm CPE (440 mm).

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Kumar *et al.* (2002) evaluated that the influence of irrigation schedules on seed yield, water use and water use efficiency of summer green gram during summer season of the year 1998, at Crop Research Farm, Haryana Agricultural University, Hisar, (Haryana) on sandy loam soil. The results revealed that an increase in irrigation frequency increased the seasonal water use but decreased the water use efficiency.

Patel *et al.*, (2005), conducted an experiment during summer season of the year 2001 at Instructional Farm, N. M. College of Agriculture, Navsari Agricultural University, Navsari, (Gujarat). They found that consumptive use of water was higher under irrigation at 0.9 IW: CPE ratio of summer black gram over 0.7 and 0.5 IW: CPE ratio respectively.

A field experiment was conducted at Main Pulses Research Station, Gujarat Agricultural University, Sardarkrushinagar (Gujarat) to study the response of summer cluster bean to irrigation based on cumulative pan evaporation ratio under varying doses of fertilizers. They observed that maximum consumptive use was recorded under 0.8 IW: CPE ratio (500 mm) than 0.6 IW: CPE and 0.4 IW: CPE ratios (Patel *et al.*, 2007).

Prajapati *et al.*, (2007), an experiment was conducted on sandy loam soils at college Agronomy Farm, Anand Agricultural University, Anand, (Gujarat), during summer season of the year 2003 to study the influence of irrigation and plant growth regulator on summer

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greengram. They observed that maximum consumptive use was recorded under 0.8 IW: CPE ratio (450 mm) than 0.6 IW: CPE and 0.4 IW: CPE ratio.

Patel (2008), conducted an experiment on sandy loam soils at college Agronomy Farm B.A. college of Agriculture, Anand Agricultural University, Anand (Gujarat) during summer season of the year 2007 on influence of irrigation and growth regulator on summer cowpea. They observed that maximum consumptive use was recorded under irrigation 0.8 IW: CPE ratio (415mm) than 0.6 and 0.4 IW: CPE ratios.

2.2.4 Effect of Irrigation schedules on Water Use Efficiency

Tank *et al*, (1992) conducted a field experiment during the summer season of the year 1988 at Instructional Farm, Gujarat Agricultural University, Junagadh, (Gujarat) to study the response of 'K 851' summer green gram to irrigation. Results revealed that the water use efficiency recorded at 0.8 IW: CPE ratio was significantly higher than 1.0 and 0.6 IW: CPE ratios.

Kher *et al*, (1994) conducted a field experiment during summer season of the year 1989 at Instructional Farm, Gujarat Agricultural University, Junagadh, (Gujarat), to study water and nutrient management of summer cowpea. They found that different IW: CPE ratios did not exert their significant influence on water use efficiency.

Pawar and Gathe (1994) conducted an experiment on sandy

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clay loam soil to study the response of summer mungbean to irrigation Mahatma Phule Krishi Vidyapith, Rahuri, (Maharashtra), during summer season of the year 1991. Results indicated that the water use efficiency decreased with increased in the number of irrigations. It was higher under all the treatments when two irrigations were applied, but it was the lowest when the irrigation was scheduled at 50 mm CPE, followed by 75 mm CPE.

A field investigation was conducted by Bhadoria and Bhadoria (2002) to study the response of irrigation on growth and yield of Guar and Mungbean at Jawaharlal Nahru krishi Vidyapith, Gwalior, (Madhya Pradesh) during summer season of the year 1992-93 and 1993-94 on sandy clay loam soil. Results revealed that the water use efficiency (WUE) was the highest under IW: CPE ratio of 0.4, but it was decreased with increase in the number of irrigations.

Patel *et al*, (2005) conducted an experiment during summer season of the year 2001 at Instructional Farm, N. M. College of Agricultural, Navsari Agriculture University, Navsari, (Gujarat). They found that water use efficiency was higher under irrigation at 0.9 IW: CPE ratio and water expense efficiency was higher under irrigation at 0.5 IW: CPE ratio of summer black gram over 0.7 IW: CPE ratio.

Prajapati *et al*, (2007) conducted an experiment on sandy loam soils at College Agronomy Farm, B. A. College of Agriculture, Anand Agricultural University, Anand, (Gujarat), during summer season of the year 2003 on influence of irrigation and growth

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regulator on summer green gram. They observed that maximum water use efficiency recorded under 0.8 IW: CPE ratio (450 mm) than 0.6 IW: CPE and 0.4 IW: CPE ratio.

Patel (2008) conducted an experiment on sandy loam soils at college Agronomy Farm B.A. college of Agriculture, Anand Agricultural University, Anand (Gujarat) during summer season of the year 2007 to study the influence of irrigation and plant growth regulator on summer cowpea. They found that maximum Water use efficiency recorded under irrigation 0.8 IW: CPE ratio than 0.6 and 0.4 IW: CPE ratio.

2.2.5 Effect of Irrigation schedules on quality

A field experiment conducted during the summer season of the year 1986 and 1987 on green gram at Jawaharlal Nehru Krishi Vidyapith, Zonal Agriculture Research Station, Morena (M. P.) on sandy loam soil, results indicated that irrigation at 100 mm CPE recorded significantly higher protein content (%) and protein yield (kg/ha) as compared to irrigation at 150 and 200 mm CPE (Tomar *et al.*, 1993).

Soni and Gupta (1999) from Water Management Research Station, Pouni chok, Sher-e- Kashmir University of Agricultural Sciences (Jammu and Kashmir) reported that protein content (%) was non significantly affected by moisture regimes on summer green gram but protein yield significantly increased with five irrigations applied at interval of 15 days.

2.1.6 Economics of Irrigation schedules

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In a field investigation conducted by Bhadoria and Bhadoria (2002) to study the response of irrigation on growth and yield of *Guar* and *Mungbean* at Jawaharlal Nehru Krishi Vishwa Vidyapith, Gwalior, (Madhya Pradesh) during summer season of the year 1992-93 and 1993-94 on sandy clay loam soil, it was found that higher IW: CPE ratio of 1.0 gave the highest net returns per hectare (Rs. 31,876) and higher cost - benefit ratio (1:1.85).

A field experiment was conducted during the summer season of the year 1999 and 2000 at Main Pulses Research Station, Gujarat Agriculture University, Sardar Krushinagar, (Gujarat). They found that the highest BCR with 14607 Rs/ha net realization under irrigation at an IW: CPE ratio of 1.0 (Patel, *et al.*, 2005)

An experiment conducted at Instructional Farm, N. M. College of Agriculture Navsari, Agricultural University, Navsari, (Gujarat). during the summer season of the year 1992-93 and 1993-94 on deep black clayey soil, results revealed that the maximum gross return Rs. 12497 ha⁻¹ and net return Rs. 6907 ha⁻¹ were realized at 0.75 IW: CPE ratio, followed by 0.60, 0.45 and 0.30 IW: CPE ratio, respectively (Dabhi *et al.*, 2000).

From the results of an experiment conducted at Experimental Farm, Annamalai University, Annamalai Nagar (Tamil Nadu) on clay loam soil during summer season of the year 1998, Kavita and Wahab (2000) noticed that irrigation at an IW: CPE ratio of 0.6 along

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with Sugarcane trash mulching at 10 cm thickness recorded the highest yield gross and net returns as well as return per rupee invested during both the seasons.

MATERIAL AND METHODS

The detail of the material used, experimental method followed and technique were adopted during the course of investigation on “Influence of date of sowing and irrigation scheduling (IW:CPE ratios) on growth, yield attributes and yield of summer moth bean (*vigna acontifolia* (jacq.) Marechal) under middle Gujarat conditions” are given below.

3.1 Experimental site

The present experiment was conducted in plot number A 34 at College Agronomy Farm, B A College of Agriculture, Anand Agricultural University, Anand, (Gujarat) during summer season of the year 2010.

3.2 Climate and weather condition

Geographically, Anand is situated at 22° 35' N latitude, 72° 55' E longitude with an elevation of 45.1 m above the mean sea level. The climate of this region is semi arid and sub tropical. Monsoon commence by the third week of June and retreat by middle of the september with an average rainfall of 870 mm received entirely from the south west monsoon current. The rains are adequate in this region. Partial failure of rain once in three or four years is very common. July and August are the months of heavy precipitation. Particularly there is no rainfall in winter and summer in almost all part of Gujarat. Except, sporadic shower in *Rabi* season. Winter is severe and sets in the month of November and continued till the

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end of January. Summer is hot and dry, covers the month of April-May. The observations on the meteorological parameters for the period of investigation during summer season of the year 2010 recorded at the meteorological observatory of the Anand Agricultural University, Anand are presented in Table 3.1 and graphically depicted in Fig. 3.1 The mean minimum temperature ranged from 12.2^o C to 23.7^o C and mean maximum temperature ranged from 30.3^o C to 41.7^o C during the crop season of the year 2010. The other weather parameters viz, average relative humidity, wind velocity and bright sunshine hours observed during the experiment period. The unseasonable rainfall was not received during study period. In general, the weather conditions were favourable for normal crop growth. The data regarding daily pan evaporation measured from USWB class 'A' pan evaporimeter during the experimental period are presented in Table 3.2.

3.3 Soil characteristic

The experimental field had an even topography with a gentle slope and good drainage. The soil is representative of the soils of the region and is particularly known as 'Goralu soil'. The texture of the soil is loamy sand. It is alluvial in origin and belongs to the entisols. It responds well to manuring and is suitable to variety of crop of tropical region. The soil is very deep and moisture retentive. The composite soil samples were collected from the experimental plot up to the depth of 0-15 cm before sowing of the crop were

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analyzed for determining the physical and chemical properties of soil, details of which are presented in Table 3.3. The soil chemical analysis indicated that soil was low in nitrogen, medium in available phosphorus and high in available potash. The soil is free from any kind of salinity and sodicity.

Table 3.1 Meteorological data recorded during the course of investigation

Month & Years	Met. Std. Week	Dates	Temp. (°C)		Sunshine (Hrs/day) (BSS)	Evaporation (mm)	Ave. Relative Humidity (%)
			Max.	Min.			
Jan. 2010	1	01-07	27.5	11.1	7.0	3.3	65.7
	2	08-14	27.8	12.5	9.0	3.5	58.2
	3	15-21	28.1	11.6	8.9	3.6	59.0
	4	22-28	30.7	11.8	9.9	3.7	58.7
	5	29-04	29.9	13.3	9.0	3.6	60.0
Feb, 2010	6	05-11	31.0	16.2	7.6	5.2	58.8
	7	12-18	30.2	12.5	9.8	5.1	49.9
	8	19-25	32.5	14.8	9.1	5.1	47.4
	9	26-04	34.9	16.6	9.6	5.6	49.5
March, 2010	10	05-11	34.4	18.8	8.8	7.3	44.6
	11	12-18	38.1	17.3	9.6	6.9	43.6
	12	19-25	39.8	19.3	9.2	7.6	45.9
	13	26-01	37.2	20.8	9.4	7.8	51.9
April, 2010	14	02-08	38.6	21.6	9.6	9.4	43.3

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	15	09-15	39.5	22.9	7.2	8.7	54.9
	16	16-22	40.8	24.6	10.2	9.2	55.4
	17	23-29	41.1	23.1	11.1	11.7	39.9

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Table 3.3: Physico-chemical properties of the soil of experimental plot (Initially)

Sr. No.	Particular	Soil Depth (cm) 0-15	Method adopted
Physical Parameters			
1	Coarse sand (%)	0.47	International pipette method (Piper,1950)
2	Fine sand (%)	80.35	International pipette method (Piper,1950)
3	Silt (%)	12.88	International pipette method (Piper,1950)
4	Clay (%)	6.30	International pipette method (Piper,1950)
5	Textural class	Loamy sand	
Chemical Parameters			
1	Soil pH (1:2.5)	7.7	Backman pH meter (Jackson,1973)
2	Organic carbon (%)	0.43	Walkly and Black method (Piper,1950)
3	Total nitrogen (%)	0.033	Kjeldahl's method (Jackson,1973)
4	Available P ₂ O ₅ kg/ha	50.08	Olsen's method (Olsen <i>et al</i> , 1954)
5	Available K ₂ O kg/ha	285.91	Flame photometer method (Jackson,1973)

3.4 Cropping history of the experimental site

The cropping history of the experimental plot for preceding three year are presented in Table 3.4

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3.5 Crop and variety

The moth bean variety “RMO-225” is released from Swami Kesavanand Rajasthan Agricultural University, Bikaner, (Rajasthan).

The details of the variety are presented in Table 3.5

Table 3.4 The crop taken during last three year in the experimental plot

Year	Season	Crop	Fertilizer (kg/ha)		
			N	P	K
2007-08					
	Kharif	Sorghum	80	40	00
	Rabi	Pigeon pea	20	40	00
	Summer	Bajra	80	40	00
2008-09					
	Kharif	Fallow	-	-	-
	Rabi	Lucerne	25	75	00
	Summer	Fallow	-	-	-
2009-10					
	Kharif	Bajra	80	40	00
	Rabi	Fallow	-	-	-
	Summer	Moth bean (Experiment)	20	40	00

Table 3.5: Characteristics of Moth bean cultivar (RMO-225)

Sr. No.	Character	RMO-225
1	Plant height (cm)	30-35 (cm)
2	No. of pod per plant	40-50
3	No. of grain per plant	4-6
4	Length of pod (cm)	3-5
5	Days to 50% flowering	25-30
6	Seed colour	Dark brown
7	Maturity days	90
8	Seed yield (kg/ha)	500-600 (kg/ha)

3.6 Experimental detail

The detail of experimental techniques employed for the

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investigation of “ Influence of date of sowing and irrigation scheduling (IW:CPE ratios) on growth, yield attributes and yield of summer moth bean (*vigna acontifolia (jacq.) Marechal*) under middle Gujarat conditions” are describe as under.

3.6.1 Treatment detail

A. Main plot treatment: Date of sowing (D) - 4 levels

D₁ = 20th January

D₂ = 30th January

D₃ = 9th February

D₄ = 19th February

B. Sub plot treatment: Irrigation scheduling (I) - 4 levels

I₀ - critical growth stages. (Control)

- At Branching, at flowering, at pod formation, at grain formation.

I₁ - 0.5 IW: CPE ratio

I₂ - 0.7 IW: CPE ratio

I₃ - 0.9 IW: CPE ratio

Note : Irrigation depth = 50 mm

Treatment combination

Sr. No.	Treatment combination	Sr. No.	Treatment combination
1.	D ₁ I ₀	9.	D ₃ I ₀
2.	D ₁ I ₁	10.	D ₃ I ₁
3.	D ₁ I ₂	11.	D ₃ I ₂
4.	D ₁ I ₃	12.	D ₃ I ₃
5.	D ₂ I ₀	13.	D ₄ I ₀
6.	D ₂ I ₁	14.	D ₄ I ₁
7.	D ₂ I ₂	15.	D ₄ I ₂
8.	D ₂ I ₃	16.	D ₄ I ₃

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3.6.2 Experimental design and lay out

1. Experimental Design : Strip plot
2. Number of replication : Four
3. Seed rate : 15 kg/ha
4. Spacing : 60 cm × 10 cm
5. Plot size : Gross plot - 3.60 m × 6.00 m
: Net plot - 2.40 m × 5.00 m
6. Total number of plot : 64
7. Crop and variety : Moth bean, Variety "RMO-225"
8. Fertilizer (kg/ha) : N (20 Kg) + P (40 Kg) +
K (00 Kg)
9. Season : Summer

3.7 Cultural operations

The experimental field was thoroughly prepared by tractor cultivator followed by harrowing and at last planking for leveled the soil. The sequence of operations carried out in the field during the course of investigation is given in Table 3.6.

3.7.1 Application of fertilizer

The crop was fertilized with 20 kg N and 40 kg P₂O₅ per hectare from DAP and urea as basal application i.e. before sowing in opened furrow as common application.

3.7.2 Sowing of the experiment

The seeds of Moth bean were used for sowing. As per the date of sowing treatments, first, second, third, and four sowing was done

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manually on 20th January, 30th January, 9th February and 19th February 2010, respectively. First treated seed with Rhizobium culture 'pv movable' @ 400gm/20kg seeds and then dry sowing was done at 60 cm row to row and 10 cm plant to plant distance. As sowing was performed under dry condition and the seeds were covered with the soil by manually.

Table 3.6 Calendar of cultural operations carried out during the experiment.

Sr. No.	Operations	Frequency	Date	
(A) Pre Sowing Operation				
1	Tractor cultivation, harrowing and planking	Once	18/01/2010	
2	Field layout	Once	19/01/2010	
3	Application of fertilizer (As per date of sowing)	Once	D ₁	20/01/2010
			D ₂	30/01/2010
			D ₃	09/02/2010
			D ₄	19/02/2010
4	Sowing (As per date of sowing)	Once	D ₁	20/01/2010
			D ₂	30/01/2010
			D ₃	09/02/2010
			D ₄	19/02/2010
(B) Post Sowing Operation				
8	Thinning (As per treatment)	Once in each date of sowing	D ₁	04/02/2010
			D ₂	14/02/2010
			D ₃	24/02/2010
			D ₄	06/03/2010
9	Weeding and hoeing (As per treatment)	Once in each date of sowing	D ₁	10/2/2010, 26/2/2010
			D ₂	20/02/2010, 08/3/2010
			D ₃	02/03/2010, 18/3/2010
			D ₄	23/03/2010, 08/4/2010

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10	Plant protection measures (As per treatment)	First date of sowing (D ₁)	Monocrotophos 36 EC, Blitox, Hostathion 40 EC, Imidachlorpid, Chlorpyriphos 20 EC for the control of thrips, Macrofomia Mosaic and termite
		Second date of sowing (D ₂)	Quinalphos 26 EC, Imidachlorpid, Chlorpyriphos 20 EC for the control of thrips, mosaic and termite
		Third date of sowing (D ₃)	Quinalphos 26 EC, Imidachlorpid, Chlorpyriphos 20 EC for the control of thrips, mosaic and termite
		Fourth date of sowing (D ₄)	Quinalphos 26 EC, Imidachlorpid, Chlorpyriphos 20 EC for the control of thrips, mosaic and termite
11	Watching of birds	For 15 days in each date of sowing	
(C) Other Operations			
12	Picking (As per date of sowing)	At maturity stage of pod	

3.8 Post sowing operations

One common irrigation of 50 mm depth was given immediately after sowing the seeds. Thinning, weeding and plant protection measures were taken as and when required.

3.8.1 Thinning

After twenty days after sowing, thinning was carried out to maintain a uniform plant stand in respective dates of sowing treatment.

3.8.2 Weeding and hand hoeing

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Hand weeding and hoeing operation were carried out once in each date of sowing at 20 and 35 days after sowing respectively, for effective control of weeds and making soil friable.

3.8.3 Plant protection

The crop was infected with jassid, thrips, pod borer macrofomia as well as yellow vein mosaic disease and control measures were adopted by timely spraying of different insecticide / pesticide like Monocrotophos 36 EC @ 10 ml/10 liter water, Hostathion 40 EC, drenching of Blitox fungicide for control of macrofomia and Rogor for yellow vein mosaic disease. The crop also infected with termite and it was controlled by applying Chlorpyriphos 20 EC drop by drop with irrigation water.

3.8.4 Harvesting, threshing, cleaning and winnowing

Pods were harvested manually when they turned brown to dark brown. The pods from border lines were harvested first and kept separately. Then, the pods from net plot were manually picked and allowed to sun dry for four days in cotton bags. The seed weight of each net plot was done by pan balance and recorded for each net plot separately. The straw yield of each net plot was also recorded and converted on hectare basis.

3.8.5 Other operation

3.8.6 Watching of birds

3.9 Irrigation scheduling

The irrigation treatment was imposed after establishment of

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the crop, common irrigation was given immediately after sowing. The detail regarding dates of the irrigation for treatments along with number of irrigation and total quantity of water applied are given in Table 3.7.

The cumulative pan evaporation values were calculated from daily pan evaporation measured with the help of USWB class 'A' open pan evaporimeter installed at meteorological observatory, which was in the proximity of the experimental plot. The quantity of irrigation water applied in surface flooding was measured by 7.0 cm head parshall flume. A fixed depth of 50 mm irrigation water was applied to each treatment at irrigation based on IW: CPE ratios of 0.5, 0.7 and 0.9, respectively.

3.10 Soil physical constant

Soil physical constant viz. field capacity, permanent wilting point and bulk density were determined for experiment at site up to 60 cm depth. The values are presented in the Table 3.8 along with procedure followed.

3.11 Soil moisture studies

The soil moisture studies were started right from sowing of crop and continued up to its maturity. The soil moisture constant of all the treatments in one replication was determined on same day just before irrigation and 48 hours after irrigation at 0-15, 15-30, 30-45 and 45-60 cm soil depth were recorded.

3.11.1 Sampling technique

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Soil samples were taken with the help of screw auger from four different soil depths. The soil samples were taken around fixed spot selected at random in net plot area of each treatment from one replication. The samples were transferred immediately to aluminum boxes and covered with gunny bag to avoid moisture losses from the samples. The samples were shifted immediately for oven dry.

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Table 3.8: Physical constant of the soil experimental plot

Depth (cm)	Physical constant of soil		
	F. C. %	P.W.P. %	B. D. g/cc
0-15	13.50	4.44	1.34
15-30	13.09	4.65	1.40
30-45	12.78	5.05	1.48
45-60	23.41	5.1	1.56
Procedure Followed	Actual field method (Dastane, 1972)	Pressure plat apparatus method (Richard,1948)	Actual field method (Dastane, 1972)

3.11.2 Weighting and drying of sample

The soil samples were weighed (W_1) by physical balance immediately and then transferred to electrically heated oven with thermostat control. The samples were dried at temperature of 105° C for 8 to 12 hrs. till constant weight (W_2) was obtained.

The loss in soil moisture was expressed in percentage on oven dry weight basis with following formula.

$$\text{Moisture percentage} = \frac{W_1 - W_2}{W_2} \times 100$$

Where, W_1 = wet soil sample
 W_2 = dry soil sample

The values were used to compute the seasonal consumptive use of water and moisture use rate.

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3.11.3 Consumptive use of water

The consumptive use of water under different treatments was computed by using the following formula as described by Mishra and Ahmad (1987).

$$\begin{aligned} \text{CU of water (mm)} = & (E_0 \times 0.6) + \text{Profile soil moisture} + \text{Effective} \\ & \text{rainfall} \\ & + \text{Ground water contribution.} \end{aligned}$$

The depth of water table was more than three meters below the surface throughout the period of experimentation. Hence, the ground water contribution was considered as zero. The profile soil moisture (depletion) was worked out as under which is described by Patel (1993),

$$d = \frac{\sum M_{1i} - M_{2i}}{100} \times A_{si} \times D_i$$

Where, d = Moisture deficit in the root zone,

\sum = Summation of 'n' number of the root zone,

M_{1i} = Soil moisture in the i^{th} layer of profile after irrigation,

M_{2i} = Soil moisture in the i^{th} layer of profile on the day before next,

A_{si} = Apparent specific gravity of the layer (Bulk density of i^{th} layer),

D_i = Depth of i^{th} layer,

E_0 = PE mm/day (from saturation to FC)

3.11.4 Moisture extraction pattern

The soil moisture extraction pattern is the relative amount of

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moisture extracted from different soil depths within the crop root zone. Samples from four different soil depths viz, 0-15, 15-30, 30-45 and 45-60 cm soil depth were taken to determine to the moisture extraction pattern and the sum was expressed in the percentage of total water used.

3.11.5 Water use efficiency (kg/ha-mm)

The response of seed yield per unit of irrigation water used at varying level of irrigation was worked out by dividing per hectare seed yield of moth bean crop obtained under various treatment with the total consumptive use of water (mm) of the respective treatment and it was recorded as water use efficiency which was worked out by the followed formula which is described by Patel (1993).

$$\text{WUE (Kg/ha-mm)} = \frac{\text{Seed yield (kg/ha)}}{\text{Total consumptive use of water (mm)}}$$

3.12 Biometric observations

The details of the various growth and yield attributes as well as quality parameters studied during the course of investigation are given in Table 3.8 along with size of samples and time of observation. The details of treatment followed for recording above stated biometric observations are given as under.

3.12.1 Plant population and Growth attributes

The details of technique employed for recording observation on growth characters are described below.

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3.12.1.1 Plant population

Plant population at 15 DAS and at harvest was recorded by counting number of plants in each net plot.

3.12.1.2 Plant height

The plant height of previously selected and tagged five plants were measured at 30, 60 DAS and at harvest. Average value for each treatment at each stage was calculated and recorded.

3.12.2 Yield attributing characters

Five randomly selected and tagged plants from each plot were used for recording observation on yield attributes.

3.12.2.1 Days to 50 percent flowering

The numbers of days required for the crop to attain 50 percent flowering was recorded from randomly each net plot. The mean value for each experimental plot was worked out and recorded.

3.12.2.2 Length of pod (cm)

Pod length was measured from base of pod to the tip of pod from randomly selected five pods taken from five tagged plants and average value of pod length for each plot was worked out and noted for each treatment.

3.12.2.3 Number of pods per plant

The total numbers of pods picked from selected and tagged five plants were counted and average value per plant was worked out and recorded from each treatment.

3.12.2.3 Number of seeds per pod

Randomly selected five pods were used for counting the

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number of seeds per pod and average value per pod was recorded for each treatment.

3.12.2.4 Test weight of 100 seeds, (g)

One hundred grains of moth bean were counted from the composite sample of seeds drawn from the produce of the net plot for each treatment and weight was recorded separately.

3.12.2.5 Seed yield and dry gotar yield - (kg/ha)

The pods of each net plot were threshed and cleaned seeds were separated and the seed yield was recorded. Dry gotar yield was obtained by subtracting the seed yield of each net plot from their respective total dry matter (above ground) or biological yield computed per net plot and then converted it on hectare basis.

3.12.2.6 Harvest index

Harvest index is the ratio of economic yield to the biological yield per plot. It was calculated by using following formula suggested by Donald and Hamblin (1976).

$$\text{Harvest index (\%)} = \frac{\text{Economic yield (kg/ha)}}{\text{Biological yield (kg/ha)}}$$

3.13. Quality parameter

3.13.1 Protein content (%)

Protein content of moth bean was worked out by multiplying the N content of seed with a factor 6.24 The concentration of N was determined through a modified Kjeldahl's procedure (Jackson, 1973).

3.15 Economics

Cost of cultivation of the crop for individual treatment was worked

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out taking into considering the cost of all the cultivation operations starting from preparatory tillage to harvesting of the crop including the cost of all the inputs.

The gross realization and net realization in terms of Rs/ha was worked out taking the present market value of seeds and dry gotar obtained for each treatment. The net realization was worked out by subtracting the total cost of production from gross realization of treatment and recorded accordingly.

$$\text{CBR} = \frac{\text{Total income (Rs/ha)}}{\text{Total expenditure (Rs/ha)}}$$

$$\text{Net CBR} = \text{CBR}-1$$

3.16 Statistical analysis

The data generated on yield, quality and various characterized were subjected to statistical analysis using “Analysis of variance technique”. The value of table ‘F at 5 % level of significance, where the treatment differences were found significant the value of CD and C.V. %were also worked out to compare the treatment mean (Snedecor and Cochran, 1967).

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Table 3.9 Parameters studied during course of investigation

(A) Growth attributes			
1	Plant population	Net plot	At 15 DAS and at harvest
2	Plant height (cm)	Counted by randomly selected and tagged five plant in plants in each net plot and in each replication	At 30,60 DAS and at harvest
(B) Yield attributes			
1	Days to 50% flowering	Selected and tagged five plants	At flowering
2	Day to maturity	Net plot	Maturity stage
3	No. of pods per plant	Selected and tagged five plants	At harvest
4	Length of pod (cm)	Five selected plants	At harvest
5	No. of seeds per pod	Five selected plants	At harvest
6	100-Seed weight	Five selected plants	At harvest
7	Seed yield kg/ha	Net plot	At harvest
8	Dry gotar yield kg/ha	Net plot	At harvest
9	Harves index (%)	Net plot	At harvest
© Quality parameter			

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1	Protein (%)	Seed sample from net plot	After harvesting
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EXPERIMENTAL RESULTS

Results of the field experiment entitled, “Influence of date of sowing and irrigation scheduling (IW:CPE ratios) on growth, yield attributes and yield of summer moth bean (*vigna acontifolia (jacq.) Marechal*) under Middle Gujarat conditions“ conducted at college Agronomy Farm, B. A. College of Agriculture, Anand, Gujarat Agricultural University, Anand, during *summer* season of the year 2010 are presented in this chapter along with the statistical inferences. The data pertaining to growth characters, yield attributes yield and quality were subjected to statistical analysis. Data for all main effects and only significant interactions of date of sowing and irrigation scheduling on result of different observations are being presented and described in the subsequent paragraphs of this chapter. The results have also been depicted graphically wherever, it is necessary.

This chapter mainly divided in four different major headings, which are as follow:

- 4.1 Growth parameters
- 4.2 Yield attributes and yield
- 4.3 Quality characters
- 4.4 Soil moisture studies
- 4.5 Economics

4.1 PLANT POPULATION AND GROWTH PARAMETERS

4.1.1 Plant population

The data regarding the effects of different dates of sowing and levels of irrigation scheduling (IW:CPE ratios) on plant population of moth bean, recorded at 15 days after sowing and at harvest is presented in Table 4.1.

Results

Table 4.1. Effect of date of sowing and irrigation scheduling (I W:CPE ratios) on plant population at 15 DAS and at harvest

Treatments	Plant population/ net plot	
	At 15 DAS	At harvest
A Vertical strip (Date of sowing) (D)		
D ₁ : 20 th January	55.17	40.07
D ₂ : 30 th January	55.58	42.80
D ₃ : 9 th February	58.91	42.17
D ₄ : 19 th February	57.83	40.27
S.Em. ±	1.07	0.82
C.D. at 5	NS	NS
C.V. %	7.50	7.96
B Horizontal strip (Irrigation IW:CPE ratios) (I)		
I ₀ : Control (Irrigation at Critical growth stage)	56.17	43.52
I ₁ : 0.5 IW:CPE ratio	57.34	40.27
I ₂ : 0.7 IW:CPE ratio	56.89	40.73
I ₃ : 0.9 IW:CPE ratio	57.08	40.78
S.Em. ±	0.47	1.12
CD at (5%)	NS	NS
CV (%)	3.33	10.84
D x I Interaction effect		
C.D. at 5	NS	NS
C.V. %	4.76	9.73

4.1.1.1 Effect of date of sowing

The results indicated that the different date of sowing did not exert their significant influenced on plant population at 15 DAS and at harvest. It was indicated that plant population was uniform.

4.1.1.2 Effect of irrigation scheduling (IW:CPE ratios)

The results revealed that the different levels of irrigation scheduling (IW:CPE ratios) did not exert their significant influence on plant population at 15 DAS and at harvest.

Results

4.1.1.3 Interaction effect

The results indicated that the interaction effect between irrigation scheduling was non-significant with respect to plant population at 15 DAS and at harvest (Table 4.1).

4.1.1 Plant height (cm)

The data on plant height at 30 and 60 DAS and at harvest as influenced by date of sowing and irrigation scheduling (IW:CPE ratios) are given in Table 4.2 and also depicted graphically in Fig. 4.1.

Data presented in Table 4.2 indicated that the different treatments have remarkable effect on plant height at 30 and 60 DAS and at harvest. It was also clear from the data that plant growth was slower at the beginning and faster nearer to the harvesting stage.

4.1.1.1 Effect of date of sowing

The effect of date of sowing on plant height at 30 and 60 DAS and at harvest were significant (Table 4.2). Sowing of the crop at 30th January (D₂) recorded the highest plant height (10.00 cm, 19.50 cm and 27.05 cm at 30, 60 DAS and at harvest, respectively). While the lowest plant height (6.25 cm, 16.33 cm and 21.13 cm at 30, 60 DAS and at harvest, respectively) was observed under 20th January sowing (D₁). Treatments D₃ sowing date (9th Feb.) and D₄ (19th Feb.) were remained at par with each others at 30 DAS. Similar trend was also observed at 60 DAS and at harvest.

Table 4.2. Effect of date of sowing and irrigation scheduling (I W:CPE ratios) on plant height (cm) at 30, 60 DAS and at harvest

Treatment	Plant height
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Results

	At 30 DAS	At 60 DAS	At harvest
A Vertical strip (Date of sowing) (D)			
D ₁ : 20 th January	6.25	15.17	21.13
D ₂ : 30 th January	10.00	19.50	27.05
D ₃ : 9 th February	8.86	17.42	25.21
D ₄ : 19 th February	8.53	16.35	24.56
S.Em. ±	0.36	0.32	0.34
C.D. at 5%	1.14	1.04	1.10
C.V. %	16.96	7.40	5.63
B Horizontal strip (Irrigation IW:CPE ratios) (I)			
I ₀ : Control (Irrigation at critical growth stages)	8.13	16.52	20.06
I ₁ : 0.5 IW:CPE ratio	8.39	17.03	24.39
I ₂ : 0.7 IW:CPE ratio	11.37	19.76	27.95
I ₃ : 0.9 IW:CPE ratio	9.13	17.74	24.56
S.Em. ±	0.34	0.32	0.66
C.D. at 5%	1.12	1.04	2.04
C.V. %	18.12	7.30	10.75
D x I Interaction effect			
C.D. at 5%	NS	NS	NS
C.V. %	10.81	8.11	6.64

4.1.1.2 Effect of irrigation scheduling (IW:CPE ratios)

It is cleared from data (Table 4.2) that irrigation scheduling (IW:CPE ratios) was able to exert its significant effect on plant height at 30, 60 DAS and at harvest. Treatment I₂ (: 0.7 IW:CPE ratio) recorded significantly the highest average plant height (11.37, 19.76, 27.95 cm), than rest of the irrigation levels. Treatments I₃ (0.9 IW:CPE ratio), I₁ (0.5 IW:CPE ratio) were remained at par with each others. While the lowest plant height were recorded under treatment I₀ Control (Irrigation at critical growth stages).

4.1.1.3 Interaction effect

The results indicated that the different date of sowing and irrigation scheduling (IW:CPE ratios) was non-significant.

Results

4.2 YIELD ATTRIBUTES AND YIELD

4.2.1 Days to 50% flowering

The data on days to 50% flowering of moth bean as affected by varying levels of date of sowing and irrigation scheduling (IW:CPE ratio) are presented in Table 4.3 and also graphically depicted in Fig. 4.2.

4.2.1.1 Effect of date of sowing

It is evident from the data (Table 4.3) that overall effect of date of sowing on days to 50% flowering of moth bean was significant. Sowing of crop at 30th January (D₂) resulted in significantly minimum days to 50% flowering (29.25 days). While the maximum days to 50% flowering (34.06 days) was observed under the sowing of crop at 20th January (D₁) which was remained at par with treatment D₃ (9th February).

4.2.1.2 Effect of irrigation scheduling (IW:CPE ratio)

It is further evident from data (Table 4.3) that the effect of irrigation scheduling (IW:CPE ratios) on days to 50% flowering of moth bean was significant. Significantly the highest days to 50% flowering (34.44 days) was observed under treatment I₃ (0.9 IW:CPE ratio). While the minimum days to 50% flowering (29.56) was observed under the treatment I₀ (control, irrigation at critical growth stages), which was remained at par with treatment I₁ (0.5 IW:CPE ratio).

Table 4.3 Effect of date of sowing and irrigation scheduling (IW:CPE ratios) on days to 50 % flowering

Treatments	Days to 50% Flowering
A Vertical strip (Date of sowing) (D)	

Results

D ₁ : 20 th January	34.06
D ₂ : 30 th January	29.25
D ₃ : 9 th February	33.00
D ₄ : 19 th February	30.69
S.Em. ±	0.35
C.D. at 5%	1.13
C.V. %	4.47
B Horizontal strip (Irrigation IW:CPE ratios) (I)	
I ₀ : Control (Irrigation at critical growth stages)	29.56
I ₁ : 0.5 IW:CPE ratio	31.00
I ₂ : 0.7 IW:CPE ratio	32.00
I ₃ : 0.9 IW:CPE ratio	34.44
S.Em. ±	0.50
C.D. at 5%	1.60
C.V. %	6.31
D x I Interaction effect	
C.D. at 5%	NS
C.V. %	4.94

4.2.1.3 Interaction effect

The results indicated that the interaction effect between date of sowing and irrigation scheduling (IW:CPE ratios) was non-significant.

4.2.1 Days to maturity

Data on days to maturity of moth bean as influenced by date of sowing and irrigation scheduling (IW:CPE ratios) are given in Table 4.4. The data also graphically depicted in figure 4.3.

4.2.1.1 Effect of date of sowing

A perusal of data presented in Table 4.4 showed that various dates of sowing significantly influenced the days to maturity. The treatment D₄ (sowing at 19th February) significantly recorded the lowest days to maturity (81.44 days). Significantly the highest days to maturity (105.06 days) was under treatment D₁ (sowing at 20th January).

Results

4.2.1.2 Effect of irrigation scheduling (IW:CPE ratios)

It is evident from data (Table 4.4) that days to maturity was markedly higher due to irrigation scheduling in moth bean. The treatment I_0 (control, irrigation at critical growth stages) recorded significantly minimum days to maturity (89.31). Treatments I_2 (0.7 IW:CPE ratio, 92.94) and I_1 : (0.5 IW:CPE ratio, 91.44) was remained at par with each others. Whereas the maximum days to maturity (94.44 days) were recorded by treatment I_3 (0.9 IW:CPE ratio), which was remained at par with treatment I_2 (0.7 IW:CPE ratio).

4.2.1.3 Interaction effect

The results indicated that the different date of sowing and irrigation scheduling (IW: CPE ratios) was unable to exert its significant effect on days to maturity of moth bean (Table 4.4).

Table 4.4 Effect of date of sowing and irrigation scheduling (I W:CP ratios) on Maturity

Treatments	Days to Maturity
A Vertical strip (Date of sowing) (D)	
D_1 : 20 th January	105.06
D_2 : 30 th January	94.50
D_3 : 9 th February	87.13
D_4 : 19 th February	81.44
S.Em. \pm	0.80
C.D. at 5%	2.56
C.V. %	3.48
B Horizontal strip (Irrigation IW:CPE ratios) (I)	
I_0 : Control (Irrigation at critical growth stages)	89.31
I_1 : 0.5 IW:CPE ratio	91.44

Results

I ₂ : 0.7 IW:CPE ratio	92.94
I ₃ : 0.9 IW:CPE ratio	94.44
S.Em. ±	0.77
C.D. at 5%	2.47
C.V. %	3.35
D x I Interaction effect	
C.D. at 5%	NS
C.V. %	4.02

4.2.1 Average length of pod (cm)

The data on average length of pod (cm) as influenced by date of sowing and irrigation scheduling (IW: CPE ratios) are given in Table 4.5 and also depicted graphically in Fig. 4.4.

Table 4.5 Effect of date of sowing and irrigation scheduling (IW:CPE ratios) on Average length of pod(cm)

Treatments	Average length of pod
A Vertical strip (Date of sowing) (D)	
D ₁ : 20 th January	3.57
D ₂ : 30 th January	3.78
D ₃ : 9 th February	3.74
D ₄ : 19 th February	3.67
S.Em. ±	0.04
C.D. at 5%	0.14
C.V. %	4.77
B Horizontal strip (Irrigation IW:CPE ratios) (I)	
I ₀ : Control (Irrigation at critical growth stages)	3.39
I ₁ : 0.5 IW:CPE ratio	3.76
I ₂ : 0.7 IW:CPE ratio	3.94
I ₃ : 0.9 IW:CPE ratio	3.66
S.Em. ±	0.09
C.D. at 5%	0.30
C.V. %	10.03
D x I Interaction effect	
C.D. at 5%	NS
C.V. %	7.11

Results

4.2.1.1 Effect of date of sowing

The effect of date of sowing on average length of pod was significant (Table 4.5). Sowing at 30th January (D₂) recorded significantly higher average length of pod (3.78 cm), which was remained at par with treatments D₃ (sowing at 9th February) and treatment D₄ (sowing at 19th February), respectively. While lower average length of pod (3.57 cm) was observed under treatment D₁ (sowing at 20th January), being at par with treatment D₄ (sowing at 19th February).

4.2.1.2 Effect of irrigation scheduling (IW:CPE ratio)

It is clear from data (Table 4.5) that varying levels of irrigation scheduling (IW:CPE ratios) was able to exert its significant effect on average length of pod. Treatment I₂ (0.7 IW:CPE ratio) recorded significantly higher (3.94 cm) average length of pod, which was remained at par with treatments I₁ (0.5 IW:CPE ratio, 3.76 cm) and I₃ (0.9 IW:CPE ratio, 3.66 cm.), respectively.

4.2.1.3 Interaction effect

The results indicated that the different levels of date of sowing and irrigation scheduling (IW:CPE ratios) was non-significant.

4.2.1 Average number of pods per plant

The data on main effects of different treatments on average number of pods per plant are given in Table 4.6 and also graphically depicted in Fig. 4.5.

4.2.1.1 Effect of date of sowing

The data (Table 4.6) revealed that average number of pods per plant was significantly influenced with various dates of sowing.

Results

Significantly higher average number of pods (37.81) per plant was recorded under treatment D₂ (sowing at 30th January) and it was remained at par with treatment D₃ (sowing at 9th February). Whereas, the lowest number of pods per plant (32.75) was observed under treatment D₁ (sowing at 20th January). Treatments D₃ (sowing at 9th February) and D₄ (sowing at 19th February) was remained at par with each others.

Table 4.6 Effect of date of sowing and irrigation scheduling (IW:CPE ratio) on Average number of pods per plant

Treatments	Average number of pods per plant
A Vertical strip (Date of sowing) (D)	
D ₁ : 20 th January	32.75
D ₂ : 30 th January	37.81
D ₃ : 9 th February	36.43
D ₄ : 19 th February	35.81
S.Em. ±	0.47
C.D. at 5%	1.49
C.V. %	5.21
B Horizontal strip (Irrigation IW:CPE ratios) (I)	
I ₀ : Control (Irrigation at critical growth stages)	34.57
I ₁ : 0.5 IW:CPE ratio	35.29
I ₂ : 0.7 IW:CPE ratio	37.53
I ₃ : 0.9 IW:CPE ratio	35.12
S.Em. ±	0.57
C.D. at 5%	1.84
C.V. %	6.44
D x I Interaction effect	
C.D. at 5%	NS
C.V. %	6.76

4.2.1.2 Effect of irrigation scheduling (IW:CPE ratios)

Results

It is evident from the data (Table 4.6) that varying levels of irrigation scheduling (IW:CPE ratios) was able to exert its significant effect on average number of pods per plant. Treatment I₂ (0.7 IW:CPE ratio) recorded significantly the highest average pods per plant (37.53), while lower average number of pods (34.57) was recorded under treatment I₀ (control, irrigation at critical growth stages). Treatment I₁ (0.5 IW:CPE ratio), being at par with treatment I₃ (0.9 IW:CPE ratio).

4.2.1.3 Interaction effect

The results indicated that the interaction effect between date of sowing and irrigation scheduling (IW:CPE ratios) was non-significant with respect to average number of pods per plant (Table 4.6).

4.2.1 Average number of seeds per pod

The mean data on average number of seeds per pod as influenced by different treatments are furnished in Table 4.7.

4.2.1.1 Effect of date of sowing

The data (Table 4.7) revealed that average number of seeds per pod was influenced with various date of sowing. Treatment D₂ (sowing at 30th January) recorded higher average number of seeds per pod (5.66), which was remained at par with treatment D₃ (sowing at 9th February, 5.37). Significantly lower average number of seeds per pod was recorded under treatment D₁ (sowing at 20th January), being at par with treatment D₄ (sowing at 19th February). Also, treatments D₃

Results

(sowing at 9th February) and D₄ (sowing at 19th February) remained at par with each others.

Table 4.7 Effect of date of sowing and irrigation scheduling (IW:CPE ratios) on Average number of seeds per plant

Treatments	Average number of seeds per pod
A Vertical strip (Date of sowing) (D)	
D ₁ : 20 th January	5.08
D ₂ : 30 th January	5.66
D ₃ : 9 th February	5.37
D ₄ : 19 th February	5.34
S.Em. ±	0.09
C.D. at 5%	0.29
C.V. %	6.68
B Horizontal strip (Irrigation IW:CPE ratios) (I)	
I ₀ : Control (Irrigation at critical growth stage)	5.20
I ₁ : 0.5 IW:CPE ratio	5.34
I ₂ : 0.7 IW:CPE ratio	5.66
I ₃ : 0.9 IW:CPE ratio	5.25
S.Em. ±	0.07
C.D. at 5%	0.23
C.V. %	5.42
D x I Interaction effect	
C.D. at 5%	NS
C.V. %	6.25

4.2.1.2 Effect of irrigation scheduling (IW:CPE ratios)

Data (Table 4.7) revealed that various treatments of irrigation scheduling (IW:CPE ratios) were bring perceptible variation in

Results

number of seeds per pod. Significantly the highest average number of seeds per pod (5.66) was observed under treatment I_2 (0.7 IW:CPE ratio), while the lower average number of seeds per pod (5.20) recorded under treatment I_0 (control, irrigation at critical growth stages), which was remained at par with treatments I_1 (0.5 IW:CPE ratio) and I_3 (0.9 IW:CPE ratio).

4.2.1.3 Interaction effect

The results indicated that the different date of sowing and irrigation scheduling (IW:CPE ratios) was non-significant.

4.2.1 Seed yield (kg ha⁻¹)

The mean data pertaining to the effect of date of sowing and irrigation scheduling (IW:CPE ratios) on seed yield of moth bean are presented in Table 4.8 and also graphically depicted in Fig. 4.7,

4.2.1.1 Effect of date of sowing

Date of sowing had significant effect on seed yield of moth bean (Table 4.8). Significantly the highest seed yield (460 kg/ha) was recorded under treatment D_2 (sowing at 30th January). Whereas, significantly lower seed yield (368 kg/ha) was under treatment D_1 (sowing at 20th January), being at par with treatments D_4 (sowing at 19th February), D_3 (sowing at 9th February), respectively. Treatment D_3 (sowing at 9th February) and Treatment D_4 (sowing at 19th February) were remained at par with each others. Treatment D_2 (sowing at 30th January) recorded higher seed yield to the tune of 18.26%, 19.78% and 20% over the treatments D_3 (sowing at 9th

Results

February), D₄ (sowing at 19th February) and D₁ (sowing at 20th January), respectively.

Table 4.8 Effect of date of sowing and irrigation scheduling (IW:CPE ratios) on seed yield (kg/ha)

Treatments	Seed yield
A Vertical strip (Date of sowing) (D)	
D ₁ : 20 th January	368
D ₂ : 30 th January	460
D ₃ : 9 th February	376
D ₄ : 19 th February	369
S.Em. ±	8.00
C.D. at 5%	25.78
C.V. %	8.20
B Horizontal strip (Irrigation IW:CPE ratios) (I)	
I ₀ : Control	319
I ₁ : 0.5 IW:CPE ratio	393
I ₂ : 0.7 IW:CPE ratio	472
I ₃ : 0.9 IW:CPE ratio	389
S.Em. ±	13
C.D. at 5%	41.39
C.V.%	13.16
D x I Interaction effect	
C.D. at 5%	Sig.
C.V. %	9.67

4.2.2.2 Effect of irrigation scheduling (IW:CPE ratios)

Data pertaining to effect of irrigation scheduling (IW:CPE ratios) was significant on seed yield. Significantly the highest seed yield (472 kg/ha) was observed under treatment I₂ (0.7 IW:CPE ratio), whereas significantly the lowest seed yield (319 kg/ha) was observed

Results

by treatment I_0 (control, irrigation at critical growth stages). Treatment I_1 (0.5 IW:CPE ratio) was remained at par with treatment I_3 (0.9 IW:CPE ratio). Treatment I_2 (0.7 IW:CPE ratio) recorded higher seed yield at the extent of 16.73%, 17.58%, and 32.41% over the treatments I_1 (0.5 IW:CPE ratio), I_3 (0.9 IW:CPE ratio) and I_0 (control, irrigation at critical growth stages), respectively.

4.2.1.3 Interaction effect

Interaction effect between date of sowing and irrigation scheduling (IW:CPE ratios) was significant (Table 4.9), treatment combinations (D_2I_2), 30th January date of sowing of moth bean with irrigation scheduling based on IW:CPE ratio 0.7 (9 irrigation) recorded significantly the highest seed yield (651 kg/ha). Treatment combination (D_2I_3), 30th January date of sowing with irrigation scheduling based on IW:CPE ratio 0.9 (11 irrigation) and (D_3I_2), 9th February date of sowing of moth bean with irrigation scheduling based on IW:CPE ratio 0.7 (9 irrigation) again (D_2I_1), 30th January date of sowing of moth bean with irrigation scheduling based on IW:CPE ratio 0.5 (7 irrigation) and D_1I_2 , 20th January date of sowing of moth bean with irrigation scheduling based on IW:CPE ratio 0.7 (9 irrigation), D_4I_2 19th February date of sowing with irrigation scheduling based on IW:CPE ratio 0.7 (9 irrigation) were remained at par with each others.

Significantly lower seed yield (303 kg/ha) was obtained under treatment combinations D_2I_0 , 30th January date of sowing of moth

Results

bean with irrigation scheduling based on critical growth stages being at par with treatment combination D_3I_0 , (sowing at 9th February and control, irrigation at critical growth stages), D_4I_0 (sowing at 19th February and control, irrigation at critical growth stages), D_1I_0 (sowing at 20th January and control, irrigation at critical growth stages) were remained at par with each others.

It is concluded that second date of sowing (D_2 : 30th January) and irrigation I_2 (0.7 IW:CPE ratio, 9 irrigation) was found beneficial and conducive for the highest seed yield of summer season cultivation of moth bean.

Table 4.9 Interaction effect between date of sowing and irrigation scheduling (IW:CPE ratios) on seed yield of moth bean.

Irrigation (IW:CPE ratios)				
Date of sowing/ Irrigation (IW:CPE ratios)	I_0 : Control	I_1 : 0.5 IW/CPE ratio	I_2 : 0.7 IW/CPE ratio	I_3 : 0.9 IW/CPE ratio
D_1 : 20 th January	330	376	406	360
D_2 : 30 th January	303	421	651	467
D_3 : 9 th February	319	389	430	364
D_4 : 19 th February	325	389	400	363
S.Em. \pm	19.00			
CD at 5%	55.14			
C.V. %	9.67			

4.2.1 Dry gotar yield (kg/ha)

Data regarding the effect of date of sowing and irrigation scheduling (IW:CPE ratios) on dry gotar yield of moth bean are presented in table 4.10 and also graphically depicted in Fig. 4.8

4.2.1.1 Effect of date of sowing

Date of sowing had significant effect on dry gotar yield of moth bean (Table 4.10). Significantly the higher dry gotar yield (653 kg/ha) of moth bean was recorded under treatment D₂ (sowing at 30th January), which was remained at par with treatment D₃ (sowing at 9th February), (617kg/ha). Whereas significantly the lowest dry gotar yield (578 kg/ha) was recorded under treatment D₁ (sowing at 20th January).

4.2.1.2 Effect of irrigation scheduling (IW:CPE ratios)

Data pertaining to effect of irrigation scheduling(IW:CPE ratios) revealed significant effect on dry gotar yield of moth bean. Significantly the highest dry gotar yield (664 kg/ha) was observed under treatment I₂ (0.7 IW:CPE ratio), whereas, significantly the lowest dry gotar yield (560 kg/ha) was observed under treatment I₀ (control, irrigation at critical growth stages).

Results

4.2.1.3 Interaction effect

Interaction effect between date of sowing and irrigation scheduling (IW:CPE ratios) on dry gotar yield of moth bean was non-significant.

Table 4.10 Effect of date of sowing and irrigation scheduling (IW:CPE ratios) on dry gotar yield (kg/ha)

Treatments	Dry gotar yield
A Vertical strip (Date of sowing) (D)	
D ₁ : 20 th January	578
D ₂ : 30 th January	653
D ₃ : 9 th February	617
D ₄ : 19 th February	601
S.Em. ±	16.00
C.D. at 5%	50.10
C.V. %	10.23
B Horizontal strip (Irrigation IW:CPE ratios) (I)	
I ₀ : Control	560
I ₁ : 0.5 IW:CPE ratio	614
I ₂ : 0.7 IW:CPE ratio	664
I ₃ : 0.9 IW:CPE ratio	609
S.Em. ±	12
C.D. at 5%	38.87
C.V.%	7.94
D x I Interaction effect	
C.D. at 5%	NS

Results

C.V. %	9.64
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4.2.1 1000 seeds weight (g)

The data concerned with 1000-seeds weight are presented in Table 4.11 and depicted in Fig. 4.9.

4.2.1.1 Effect of date of sowing

The appraisal of data (Table 4.11) revealed that treatment D₂ (sowing at 30th January) observed higher (19.20) test weight, which remained at par with treatment D₃ (sowing at 9th February), (18.80). Significantly lower test weight was observed (17.60) under treatment D₁ (sowing at 20th January), which was remained at par with treatment D₄ (sowing at 19th February).

Table 4.11 Effect of date of sowing and irrigation scheduling (IW:CPE ratios) on test weight of 1000 Seed weight (g)

Treatments	Test weight
A Vertical strip (Date of sowing) (D)	
D ₁ : 20 th January	17.60
D ₂ : 30 th January	19.20
D ₃ : 9 th February	18.80
D ₄ : 19 th February	17.70
S.Em. ±	0.03
C.D. at 5%	1.10
C.V. %	7.20
B Horizontal strip (Irrigation IW:CPE ratios) (I)	
I ₀ : Control (Irrigation at critical growth stages)	12.40
I ₁ : 0.5 IW:CPE ratio	20.10
I ₂ : 0.7 IW:CPE ratio	20.90
I ₃ : 0.9 IW:CPE ratio	19.90
S.Em. ±	0.03
C.D. at 5%	1.00

Results

C.V. %	6.98
D x I Interaction effect	
C.D. at 5%	NS
C.V. %	7.60

4.2.1.2 Effect of irrigation scheduling (IW:CPE ratios)

Data (Table 4.11) further showed that irrigation scheduling (IW:CPE ratios) significantly influenced the test weight. The treatment I₂ (0.7 IW: CPE ratio) recorded higher test weight (20.90g), which was remained at par with treatments I₁ (0.5 IW:CPE ratio), (20.10g) and I₃ (0.9 IW:CPE ratio). Significantly the lowest test weight was observed under treatment I₀ Control (Irrigation at critical growth stages).

4.2.1.3 Interaction effect

The results indicated that the different levels of date of sowing and irrigation scheduling (IW:CPE ratios)was non-significant.

4.2.1 Harvest index (%)

Data regarding the effect of date of sowing and irrigation scheduling (IW:CPE ratios) on harvest index (%) of moth bean are presented in table 4.12 and also graphically depicted in Fig. 4.9

4.2.2.1 Effect of date of sowing

Date of sowing had significant effect on harvest index of moth bean (Table 4.12). Significantly the highest harvest index (40.70 %) was recorded under treatment D₂ (sowing at 30th January), while significantly the lower harvest index (37.70%) was observed under treatment D₃ (sowing at 9th February). Which was remained

Results

at par with treatments D₁ (sowing at 20th January) and D₄ (sowing at 19th February).

Table 4.12 Effect of date of sowing and irrigation scheduling (IW:CPE ratios) on Harvest index (%).

Treatments	Harvest index
A Vertical strip (Date of sowing) (D)	
D ₁ : 20 th January	38.85
D ₂ : 30 th January	40.70
D ₃ : 9 th February	37.78
D ₄ : 19 th February	38.00
S.Em. ±	0.54
C.D. at 5%	1.72
C.V. %	5.54
B Horizontal strip (Irrigation IW:CPE ratios) (I)	
I ₀ : Control (Irrigation at critical growth stages)	36.29
I ₁ : 0.5 IW:CPE ratio	39.05
I ₂ : 0.7 IW:CPE ratio	41.15
I ₃ : 0.9 IW:CPE ratio	38.83
S.Em. ±	0.76
C.D. at 5%	2.43
C.V. %	7.81
D x I Interaction effect	
C.D. at 5%	NS
C.V. %	6.93

4.2.1.2 Effect of irrigation scheduling (IW:CPE ratios).

Data pertaining to effect of irrigation scheduling (IW:CPE ratios) revealed significant effect harvest index (%) of moth bean. The higher harvest index (41.15%) was recorded under treatment I₂

Results

(0.7 IW:CPE ratio), which was remained at par with treatment I₁ (0.5 IW:CPE ratio), 39.05% and I (0.3 IW:CPE ratio) 38.83%.

4.2.1.3 Interaction effect.

Interaction effect between date of sowing and irrigation scheduling (IW:CPE ratios) on harvest index (%) was non-significant.

4.3 Quality Characters

4.3.1 Protein content (%)

The mean data pertaining to the effect of date of sowing and irrigation scheduling (IW:CPE ratios) on protein content in moth bean (%) are furnished in (Table 4.13)

4.3.1.1 Effect of date of sowing

Data presented in Table 4.13 revealed that date of sowing did not exert its significant effect on Protein content of moth bean.

4.3.1.2 Effect of irrigation scheduling (IW:CPE ratio)

Data pertaining to the effect of irrigation scheduling (IW:CPE ratios) on protein content of moth bean (Table 4.13) was also non-significant.

4.3.1.3 Interaction effect

Interaction effect between date of sowing and irrigation scheduling (IW:CPE ratios) on protein content of moth bean was non-significant.

Table 4.13 Effect of date of sowing and irrigation scheduling (IW:CPE ratios) on protein content (%).

Treatments	Protein content
A Vertical strip (Date of sowing) (D)	

Results

D ₁ : 20 th January	21.7
D ₂ : 30 th January	22.5
D ₃ : 9 th February	22.2
D ₄ : 19 th February	22.3
S.Em. ±	0.27
C.D. at 5%	NS
C.V. %	4.86
B Horizontal strip (Irrigation IW:CPE ratios) (I)	
I ₀ : Control (Irrigation at critical growth stages)	21.9
I ₁ : 0.5 IW:CPE ratio	22.4
I ₂ : 0.7 IW:CPE ratio	22.5
I ₃ : 0.9 IW:CPE ratio	21.9
S.Em. ±	0.32
C.D. at 5%	NS
C.V. %	5.82
D x I Interaction effect	
C.D. at 5%	NS
C.V. %	5.16

4.4 SOIL MOISTURE STUDIES

The data revealed that different irrigation scheduling viz., I₀ Control (Irrigation at critical growth stages), I₁ 0.5 (IW:CPE ratio), I₂ : (0.7 IW:CPE ratio), and I₃ (0.9 IW:CPE ratio) received 5, 7, 9, and 11 irrigation respectively. The total quantity of irrigation water applied was 250, 350, 450, and 550 mm in respective irrigation schedules. The depth of irrigation water at each irrigation water was 50 mm.

4.4.1 Consumptive use of water (mm)

The mean values of consumptive use of water as influenced by date of sowing and irrigation scheduling (IW:CPE ratios) are illustrated in table 4.14 and graphically depicted in Fig 4.10.

Results

4.4.1.1 Effect of date of sowing

The results (Table 4.14) indicated that the different levels of date of sowing did not influenced on consumptive use of water. It was indicated that consumptive use of water was uniform.

4.4.1.2 Effect of irrigation scheduling (IW:CPE ratio)

The data (Table- 4.14) revealed that the mean consumptive use of water was influenced due to different irrigation schedules. The highest consumptive use of water (558.3mm) was recorded under treatment I₃ (0.9 IW:CPE ratio) , followed by I₂ (0.7 IW:CPE ratio), I₁ (0.5 IW:CPE ratio) and I₀ (control - irrigation at critical growth stages). In general, the consumptive use of water increased with the increase in the quantity of irrigation water.

Table 4.14 Effect of date of sowing and irrigation scheduling (IW:CPE ratios) on Consumptive use of water (mm)

Treatments	Mean Consumptive use of water
A Vertical strip (Date of sowing) (D)	
D ₁ : 20 th January	402.4
D ₂ : 30 th January	408.5
D ₃ : 9 th February	402.0
D ₄ : 19 th February	402.4
B Horizontal strip (Irrigation IW:CPE ratios) (I)	
I ₀ : Control (Irrigation at critical growth stages)	250.8
I ₁ : 0.5 IW:CPE ratio	353.7
I ₂ : 0.7 IW:CPE ratio	452.5
I ₃ : 0.9 IW:CPE ratio	558.3

4.4.2 Water use efficiency (kg/ha-mm)

Results

The mean values of water use efficiency as influenced by date of sowing and irrigation scheduling (IW:CPE ratios) are illustrated in table 4.15 and graphically depicted in Fig 4.11.

4.4.2.1 Effect of date of sowing

From the data (Table-4.15), the results revealed that the mean water use efficiency was influenced due to different date of sowing. Treatment D₂ (sowing at 30th January) recorded higher water use efficiency (1.17 kg/ha -mm). While the lowest water use efficiency (0.97 kg/ha-mm) was recorded under treatment D₁ (sowing at 20th January).

Table 4.15 Effect of date of sowing and irrigation scheduling (IW:CPE ratios) on water use efficiency (kg/ha-mm)

Treatments	Mean WUE
A Vertical strip (Date of sowing) (D)	
D ₁ : 20 th January	0.97
D ₂ : 30 th January	1.17
D ₃ : 9 th February	1.00
D ₄ : 19 th February	0.98
B Horizontal strip (Irrigation IW:CPE ratios) (I)	
I ₀ : Control (Irrigation at critical growth stages)	1.27
I ₁ : 0.5 IW:CPE ratio	1.12
I ₂ : 0.7 IW:CPE ratio	1.04
I ₃ : 0.9 IW:CPE ratio	0.70

4.4.2.2 Effect of irrigation scheduling (IW:CPE ratio)

The data (Table- 4.15) revealed that the mean water use efficiency was influenced due to irrigation scheduling (IW:CPE ratio). The highest water use efficiency (1.27 kg/ha-mm) was recorded

Results

under treatment I₀ Control (Irrigation at critical growth stages), followed by treatment I₁ (0.5 IW:CPE ratio) and I₂ : (0.7 IW:CPE ratio). While the lowest water use efficiency (0.70 kg/ha-mm) was recorded under treatment I₃ (0.9 IW:CPE ratio).

4.4.3 Moisture extraction pattern

The data regarding moisture extraction pattern by summer moth bean as influenced by date of sowing and irrigation scheduling (IW:CPE ratios) are presented in Table 4.16 and graphically depicted in Fig 4.10.

Table 4.16 Effect of date of sowing and irrigation scheduling (IW:CPE ratios) on moisture extraction pattern

Treatment	Soil depth (cm)			
	0-15	15-30	30-45	45-60
A Vertical strip (Date of sowing) (D)				
D ₁ : 20 th January	21.6	19.4	16.5	15.5
	9	6	9	8
D ₂ : 30 th January	21.2	18.7	16.4	14.9
	5	8	6	8
D ₃ : 9 th February	19.8	17.1	15.2	13.2
	4	3	1	9
D ₄ : 19 th February	18.0	16.6	14.5	11.2
	5	8	5	3
B Horizontal strip (Irrigation IW:CPE ratios) (I)				
I ₀ : Control (Irrigation at critical growth stages)	24.2	19.4	17.5	15.4
	5	0	9	3
I ₁ : 0.5 IW:CPE ratio	25.7	19.0	17.8	15.8
	5	0	1	4
I ₂ : 0.7 IW:CPE ratio	28.4	20.2	16.1	15.2

Results

	8	0	2	3
I_3 : 0.9 IW:CPE ratio	31.7	21.5	18.2	13.4
	1	0	2	7

4.4.3.1 Effect of date of sowing

The data indicated (Table 4.16) that the moisture extracted from 0-15, 15-30, 30-45, and 45-60 cm of soil depth were 21.69, 19.46, 16.59 and 15.58 percent observed under treatment D_1 (20th January) and 21.25, 18.78, 16.46, and 14.98 percent under treatment D_2 (30th January) and 19.48, 17.13, 15.21 and 13.29 percent in treatment D_3 (9th February) and 18.05, 16.68, 14.55 and 11.23 under treatment D_4 (19th February). The maximum percent of moisture was extracted from D_1 (20th January), followed by D_2 (30th January). The moisture extraction decreases with increased sowing time, whereas almost reverse trend was observed with respect to deeper layers of soil (30-45 and 45-60).

4.4.3.2 Effect of irrigation scheduling (IW:CPE ratios)

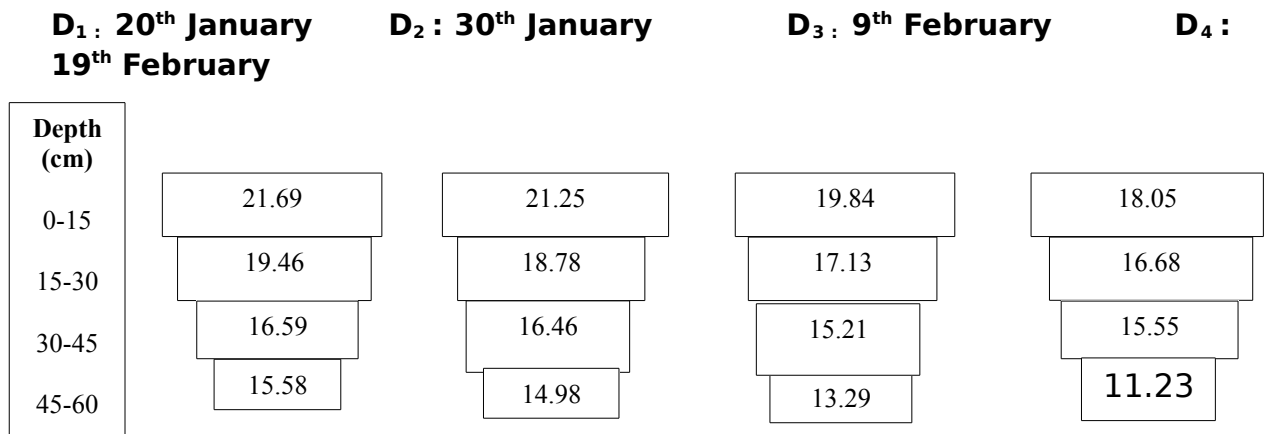
The data indicated (Table) that the moisture extracted from 0-15, 15-30, 30-45, and 45-60 cm of soil depth were 24.25, 19.40, 17.59 and 15.43 percent under treatment I_0 (control, irrigation at critical growth stages), 25.75, 19.00, 17.81 and 15.84 percent under treatment I_1 (0.5 IW:CPE ratio), 28.48, 20.20, 16.12 and 15.23 percent

Results

under treatment I_2 (0.7 IW:CPE ratio), 31.71, 21.50, 18.22 and 13.47 percent under treatment I_3 (0.9 IW:CPE ratio). The maximum percent of moisture was extracted from 0-15 cm soil depth, followed by 15-30 cm soil depth for all the treatments of irrigation. The moisture extraction increased with increase in quantity of irrigation water from upper layers of soil (0-15 and 15-30 cm soil depth), where as almost reverse trend was observed with respect to deeper layers of soil (30-45 and 45-60 cm soil depth) under the study.

Fig. 4.11 Moisture extraction pattern (%) influenced by date of sowing and irrigation scheduling (IW:CPE ratios)

A. Date of sowing



B. Irrigation scheduling (IW:CPE ratios)

Results

Depth (cm)	I ₀ : Control	I ₁ : 0.5 IW:CPE ratio	I ₂ : 0.7 IW:CPE ratio	I ₃ : 0.9 IW:CPE ratio
	0-15	24.25	25.75	28.48
15-30	19.40	19.00	20.20	21.50
30-45	17.59	17.81	16.12	18.22
45-60	15.43	15.84	15.23	13.47

4.5 ECONOMICS OF MOTH BEAN

The data pertaining to net realization, cost benefit ratio and net cost benefit ratio as influenced by different date of sowing and irrigation scheduling (IW:CPE ratio) are presented in table 4.17. The cost of cultivation per hectare was worked out and the prevailing market prices of produce are given in Appendices - I, II and III.

4.5.1 Effect of date of sowing

The data presented in table 4.17 indicated that the highest net realization (21725 Rs. per hectare) was secured under treatment D₂ sowing at (30th January), While the lowest net realization (14807 Rs. per hectare) was found under treatment D₁ sowing at (20th January). The highest net CBR (1.68) was secured under treatment D₂ sowing at (30th January).

4.5.2 Effect of irrigation scheduling (IW:CPE ratio)

Results

The data pertaining to economics in table 4.17 indicated that the highest net realization (18128 Rs. per hectare) and highest net CBR (1.04) was secured under treatment I_2 (0.7 IW:CPE ratio). While the lowest net realization (8727 Rs. per hectare) was secured under treatment I_0 (control irrigation at critical growth stages), and the lowest net CBR (0.50) was secured under treatment I_3 (0.9 IW:CPE ratio).

Treatment	yield (kg/ha)		Gross realization (Rs./ha)	Total Common cost (Rs./ha)	Treatment cost (Rs./ha)	Total cost of cultivation (Rs./ha)	Net realization (Rs./ha)	CBR	Net CBR
	Seed	Dry Gotar							
1	2	3	4	5	6	7	8	9	10
A Vertical strip (Date of sowing) (D)									
D ₁ : 20 th January	368	578	27745	12938*		12938	14807	1: 2.14	1: 1.14
D ₂ : 30 th Januar	460	653	34663	12938*		12938	21725	1: 2.68	1: 1.68
D ₃ : 9 th February	376	617	28354	12938*		12938	15416	1: 2.19	1: 1.19
D ₄ : 19 th Februa	369	601	27825	12938*		12938	14887	1:2.15	1: 1.15
B Horizontal strip (Irrigation IW:CPE ratios) (I)									
I ₀ : Control	319	560	24065	12938	2400	15338	8727	1: 1.57	1: 0.57
I ₁ : 0.5 IW:CPE ratio	393	614	29629	12938	3600	16538	13091	1: 1.79	1:0.79
I ₂ : 0.7 IW:CPE ratio	472	664	35566	12938	4800	17338	17828	1: 2.01	1:0.1
I ₃ : 0.9 IW:CPE ratio	389	609	29327	12938	6000	18938	10389	1: 1.55	1:0.55

Table 4.17 Economics of date of sowing and irrigation scheduling (IW:CPE ratios)

*Total common cost (Rs./ha) including sowing cost (Rs. 1200/ha) kg/ha

Price of Moth bean : Seed - Rs. 75

gotar - Rs. 0.25 kg/ha

Dry

DISCUSSION

The results of the investigation entitled, "Influence of date of sowing and irrigation scheduling (IW:CPE ratio) (*vigna acontifolia(jacq.)Marechal*) on growth, yield attributes and yield of summer moth bean under Middle Gujarat conditions" are described in the previous chapter. In this chapter a through attempt has been made to discuss critically these results with "cause and effect" relationship and is supported with relevant references based on experimental evidence. For the sake of convenience this chapter has been divided in to following sub heads.

- 5.1 Effect of weather on summer moth bean
- 5.2 Effect of date of sowing
- 5.3 Effect of irrigation scheduling (IW:CPE ratio)
- 5.4 Interaction effect of date of sowing and irrigation scheduling (IW:CPE ratio)
- 5.5 Effect of date of sowing and irrigation scheduling (iw:cpe ratio) on economics of summer moth bean

5.1 EFFECT OF WEATHER ON SUMMER MOTH BEAN

The weather condition during summer season of the year 2010 (Table 3.1, Fig. 3.1) was favourable for normal growth and development of moth bean. The maximum and minimum temperature, relative humidity, bright sunshine hours, and evaporation were optimum during life span of the moth bean sown

Discussion

under 30th January (D₁). All these provided congenial weather conditions favoured better growth and development which reflected significantly higher values of most of the important yield attributing components and finally higher seed yield. While, that of crop sown on 20th January (D₁), 9th February (D₃) and 19th February (D₄) was adversely affected due to prevailing of higher temperature during flowering and pod setting, relative humidity, bright sunshine hours, and evaporation, which resulted into substantially lower yield attributes and ultimately the seed yield under said treatment.

More or less moth bean crop was infested by insects – pests like Jassid, Thrips as well as by Yellow mosaic virus disease in almost all the dates, but maximum infection was observed under 20th January (D₁). Timely control measures were adopted through spraying of insecticides/pesticides. The plant population was also observed uniform. (Table 4.1). Whatever, variations were observed in the present investigation is therefore, attributed to different treatment effect and weather.

5.2 EFFECT OF DATE OF SOWING

5.2.1 EFFECT OF DATE OF SOWING ON GROWTH PARAMETERS

To obtain maximum possible yield, it is necessary for the crop to utilize equitably and efficiently all available factors viz. nutrients, light, water and Co₂. This could be obtained by uniform plant population during initial and at harvest stage was maintained as

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crop was sown by dibbling method, followed by thinning and gap filling. Consequently, the plant population in all experiment plots at initial stage and at harvest was uniform none of these date of sowing treatment influenced the plant population. This indicated that plant populations were remained uniform.

The data on periodical plant height (Table 4.2) indicated that the various dates of sowing appreciably influenced the plant height at all the growth stages 30, 60 DAS and at harvest. Sowing of the crop at 30th January (D₂) recorded the highest plant height (10.00 cm, 19.50 cm and 27.05 cm at 30, 60 DAS and at harvest, respectively. This might be due to the fact that optimum climate conditions prevailed during the vegetative growth period under 30th January (D₂) promoted the cell division and there by stem elongation that virtually increased plant growth in terms of plant height. While the lowest plant height (6.25 cm, 16.33 and 21.13 cm at 30, 60 DAS and at harvest, respectively) was observed under 20th January sowing (D₁). Treatments D₃ sowing date (9th Feb.) and D₄ (19th February) were remained at par with each others at 30 DAS. Similar trend was also observed at 60 DAS and at harvest. The reason might be due to prevailing low and high temperature which resulted into slower rate of cell division, cell elongation and ultimately produced the shortest plant. These findings are in close agreement with Chovatia *et. al.* (1993) and Hussain *et al.* (2004) for summer green gram.

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5.2.2 EFFECT OF DATE OF SOWING ON YIELD ATTRIBUTING PARAMETERS

Yield of crops is complex functions of metabolic and biochemical processes taking place in a plant system. Which may be modified by the environment and the suitable cultural practices adopted in the cultivation of the crop. Generally, economic yield depends on the fruiting organs produced by a plant. In moth bean, seed yield depends mostly on flowering, number of pods per plant, length of pod per plant, number of seeds per pod, days to maturity and test weight.

The data on (Table 4.3) days to 50% flowering showed that overall effect of date of sowing on days to 50% flowering and days to maturity (Table 4.4) of moth bean was significant. Sowing of crop at 30th January (D₂) resulted in to significantly minimum days to 50% flowering (29.25 days). While the maximum days to 50% flowering (34.06 days) was obtained under the sowing of crop on 20th January (D₁) which was remained at par with treatment D₃ (9th February). This might be due to increased temperature. Crop sown on 20th January required (34.06) days to reach 50% flowering stage, while crop sown on 30th January attained (29.25) days. Crop sown on 9th February (D₃) and 19th February (D₄) required (33) days and (30) days, respectively due to high temperature dry the stigma and spelt dropped the flowers.

Other reason that optimum climate conditions prevailed during the vegetative growth period under 30th January (D₂)

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promoted the cell division and there by stem elongation that virtually enhance the early flowering. A similar observation on early days to 50% flowering was also made by chotaliya (1998).

The data presented in (Table 4.4) showed that the treatment D₄ (sowing at 19th February) significantly recorded the lowest days to maturity (81.44 days). Significantly the highest days to maturity (105.06 days) was observed under treatment D₁ (sowing at 20th January). This might be due to the fact that high temperature during the crop sown at 19th February (D₄) accelerate the growth process and increased the photosynthetic rate so ultimately crop mature early, while the low temperature delay in maturity. These results are in accordance with the Hussain *et al.* (2004) with respect to days to 50% flowering and days to maturity of summer moong bean.

Crop sown at 30th January (D₂) recorded significantly higher average number of pods (37.81) per plant (Table 4.6), average length of pod (3.78 cm), (Table 4.5), average number of seeds per pod (5.66), (Table 4.7) and test weight (19.20g), (Table 4.11) than crop sown at (D₃) 9th February, (D₄) 19th February and (D₁) 20th January sowing, respectively.

The probable reason might be due to favourable temperature and bright sun shine hours resulted in to better growth parameters of the plants. The increase in temperature usually increase the photosynthesis simultanciouly increase the photosynthate from source to sink, ultimately higher growth parameters. Soomro (2003)

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reported that delay in sowing cause a substantial decrease in all the growth and development parameters of green gram.

The increase in yield attributing parameters might be due to higher dry matter production which resulted in to greater translocation of food materials to the reproductive parts and reflected in superiority of yield attributing parameters. These results were confirmed by Ram and Dixit (2001). The third reason might be due to favourable source sink relationship together with optimum temperature and humidity required by the crop, particularly during reproductive phase. A similar observation made by Dhanjal *et al.* (2000).

5.2.3 EFFECT OF DATE OF SOWING ON YIELD

Date of sowing had significant effect on seed yield (Table 4.8) and dry gotar yield (Table 4.9). Significantly the highest seed (460 kg/ha) and dry gotar yield (653 kg/ha) were recorded under treatment D₂ (sowing at 30th January). Whereas, significantly lower seed (368 kg/ha) and dry gotar yield (578 kg/ha) were observed under treatment D₁ (sowing at 20th January). Treatment D₂ (sowing at 30th January) recorded higher seed yield to the tune of 18.26%, 19.78% and 20% over the treatments D₃ (sowing at 9th February), D₄ (sowing at 19th February) and D₁ (sowing at 20th January), respectively.

The probable reason might be prevailing of optimum maximum and minimum temperature which have resulted in to

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higher rate of photosynthesis as well as higher translocation of photosynthates from various plant organs to the development of yield attributes which enhanced the number of pods per plant, length of pod, number of seeds per pod and test weight. Plant in the earlier and late sowing gave poor yield due to poor vegetative as well as reproductive growth.

Higher yield was mainly owing to favourable temperature during their growth period and partially due to better yield attributing characters.

Other reason might be due to higher dry matter production which resulted in greater translocation of food materials to the reproductive phase and reflected superiority of yield attributes and yield.

The probable reason could be because of relatively longer life span of crop compared with D₃ (sowing at 9th February) and (D₄) 19th February. Moderately low air humidity is favourable for seed set, provided soil moisture supply is adequate.

Lower yield in early and late sowing might be attributed to unfavourable temperature regime during the crop season i.e. low temperature in 20th January sowing (D₁) and desiccating temperature in 19th February sowing (D₄).

The reduction in yield due to delay in sowing might be attributed to less flowering and pod setting on account of unfavourable temperature accompanied by hot winds coinciding

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with flowering and pod setting stage of the late sown crop and consequence of high insect flower and pod borer infection occurred due to high air temperature . When the mean temperature was 24⁰ C all the cultivars of legume crop flowered, however, cultivars failed to flower at mean temperature of 33⁰ C. Since the mean temperature varied from 20⁰ C to more than 33⁰ C during the crop growth period might be responsible for reduction in seed yield with delayed sowing. Rowson and craven (1972) and Sahu (1986) have also reported marked reduction in seed yield of black gram due to delay sowing.

Thus, concluding the facts that early sowing D₁ (sowing at 20th January) and late sowing D₄ (sowing at 19th February) adversely affected the growth and yield attributing characters this might be due to prevailing low temperature (21⁰ C) during early sowing and high temperature (30⁰ C) during late sowing, relative humidity resulted into stunted plant growth, low vegetative and reproductive growth and insects- pests and diseases infection. while reduction in the yield, in late sowing could be attributed to high temperature especially during flowering and fruiting stage, which adversely affected the vegetative growth and flowers production. These results are in accordance with those reported by Singh *et al.* (1986), Gupta and lal (1989), Pohelma (1991), chovatia *et al.* (1993), chotaliya (1998), Dhanjal *et al.* (2000b), Ram and Dixit (2001), Patel *et al.* (2004).

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5.2.4 EFFECT ON WATER USE

The data (Table 4.14) indicated that the different levels of date of sowing did not influenced the consumptive use of water. It was indicated that consumptive use of water was uniform almost in all four dates of sowing. The mean water use efficiency was influenced due to different date of sowing. Treatment D₂ (sowing at 30th January) recorded higher water use efficiency (1.170 kg/ha-mm). While the lowest water use efficiency (0.970 kg/ha-mm) was observed under treatment D₁ (sowing at 20th January). The probable reason might be due to maximum seed yield produced under treatment D₂ (sowing at 30th January). The maximum percent of moisture was extracted from D₁ (20th January), followed by D₂ (30th January). The data indicated (Table 4.16) that the moisture extracted from 0-15, 15-30, 30-45, and 45-60 cm of soil depth were 21.69, 19.46, 16.59 and 15.58 percent observed under treatment D₁ (20th January) and 21.25, 18.78, 16.46, and 14.98 percent under treatment D₂ (30th January) and 19.48, 17.13, 15.21 and 13.29 percent in treatment D₃ (9th February) and 18.05, 16.68, 14.55 and 11.23 under treatment D₄ (19th February). The maximum percent of moisture was extracted during D₁ (20th January), followed by D₂ (30th January). The moisture extraction decreased with delay sowing time, whereas almost reverse trend was observed with respect to deeper soil layers (30-45 and 45-60 cm.).

5.2.5 EFFECT ON QUALITY

Discussion

Data presented in Table 4.13 revealed that date of sowing did not exert its significant effect on Protein content. Similar results were observed by Khan *et al.* (2000).

5.3 EFFECT OF IRRIGATION SCHEDULE (IW:CPE RATIOS)

5.3.1 EFFECT ON GROWTH PARAMETERS

Different irrigation scheduling (IW:CPE ratios) did not show significant effect on plant population (Table 4.1). This might be due to no adverse effect on germination and growth of crop. Whatever the difference observed in growth and yield attributes were mainly due to treatment effect.

Different irrigation scheduling (IW:CPE ratios) showed a remarkable influence on plant height (Table 4.2). Treatment I₂ (0.7 IW:CPE ratio) recorded significantly the highest average plant height (11.37, 19.76, 27.95 cm) at 30, 60 DAS, and at harvest, respectively. Treatments I₃ (0.9 IW:CPE ratio) and I₁ (0.5 IW:CPE ratio) were remained at par with each others. While the lowest plant height 8.13, 16.52 and 20.06 cm. were observed under treatment I₀ control (Irrigation at critical growth stages). The increase in the plant height under treatment I₂ (0.7 IW:CPE ratio) might be due to optimum supply of soil moisture surrounding root zone by favourably improving the nutrient uptake and translocation which ultimately linked with the plant growth and development in terms of plant height due to frequent irrigation (9) as compared to that of I₀ control (Irrigation (4) at critical growth stages). Optimum moisture supply promoted the cell division and cell expansion and there by stem

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elongation which virtually increased the plant growth in terms of plant height. These results are in accordance with those reported by Trivedi *et al.*, (1994), Dabhi *et al.* (1998), Kavita and Wahab (2001) for green gram.

5.3.2 EFFECT ON YIELD ATTRIBUTING PARAMETERS

Soil moisture is basic input in crop production. The availability and judicious application of water use at right time to the respective crop growth stages are vital. This might helpful in maintaining crop physiology at optimum status under better physical environment. Thus, healthy position is created for smoother running of all physiological process which enhance growth, yield attributes and ultimately crop yield.

Different irrigation scheduling (IW:CPE ratios) produced significant influence on days to 50% flowering (Table 4.3) and days to maturity (Table 4.4). Significantly the highest days to 50% flowering (34.44 days) and days to maturity (94.44 days) were recorded under treatment I₃ (0.9 IW:CPE ratio). While the minimum days to 50% flowering (29.56 days) and days to maturity (89.31 days) was observed under the treatment I₀ (control, irrigation at critical growth stages). The probable reason for that the early flowering in the treatment I₀ (control, irrigation at critical growth stages) was under soil moisture stress conditions might be fact that soil moisture deficiency due to less number of irrigation which

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induced plant for early flowering and seed production with the available resources for maintaining its progeny.

Other reason might be due to maintaining higher soil-plant-water status, better condition for cell division, cell expansion and cooler canopy which resulting in more absorption of photo synthetically active radiation and higher rates of net photosynthesis.

Maximum days to flowering and maturity were observed under treatment I₃ (0.9 IW:CPE ratio). It might be due to increasing soil moisture which favoured the luxurious plant growth which normally associated with reduction in the flower bud. In general , there is inverse relationship between vegetative and reproductive growth in the leguminous crop. Dabhi *et al.*(1998a) and parjapati *et al.* (2007) reported the similar results.

The data presented in (Table 4.5) on average length of pod, average number of pods (Table 4.6), average number of seeds per pod (Table .7) and test weight (Table 4.11) influenced by irrigation scheduling at IW:CPE ratio. Treatment I₂ (0.7 IW:CPE ratio) 9 irrigation recorded significantly higher (3.94 cm) average length of pod with maximum average number of seeds per pod (5.66). The shortest pod (3.39) in term of length was registered under treatment I₀ (control, irrigation at critical growth stages).

The probable reason might be due to several moisture stress experienced by the plants ultimately reduction in average pod length as well as the average number of seeds per pod. It has been

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observed that pod development stage is very sensitive to moisture stress. Treatment I₂ (0.7 IW:CPE ratio) assured shorter intervals between two irrigation as well as higher quantity of water application which did not permit moisture stress and created favourable conditions for the plants in respect to water and nutrient availability. Similar findings have been also reported by Tank *et al.* (1992), Trivedi *et al.* (1994) in green gram.

The data (Table 4.6) that varying levels of irrigation scheduling (IW:CPE ratios) was able to exert its significant effect on average number of pods per plant. Treatment I₂ (0.7 IW:CPE ratio) recorded significantly the highest average pods per plant (37.53), while lower average number of pods (34.57) was recorded under treatment I₀ (control, irrigation at critical growth stages). This might be due to increase in the number of irrigations applied at shorter intervals and total consumptive use of water. This situation avoided moisture stress and thus, provided very favourable conditions for moisture and nutrient availability. These results are in accordance with those of Tank *et al.* (1992), Trivedi *et al.* (1994) and Dhabi *et al.* (1998) for summer green gram.

5.3.3 EFFECT ON YIELD

The data pertaining in (Table 4.8) to effect of irrigation scheduling (IW:CPE ratios) was significant on seed yield. Significantly the highest seed yield (472 kg/ha) was observed under treatment I₂ (0.7 IW:CPE ratio), whereas, significantly the lowest seed yield (319 kg/ha) was observed under treatment I₀ (control,

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irrigation at critical growth stages). Treatment I_1 (0.5 IW:CPE ratio) was remained at par with treatment I_3 (0.9 IW:CPE ratio). Treatment I_2 (0.7 IW:CPE ratio) recorded higher seed yield at the extent of 16.73%, 17.58%, and 32.41% over the treatments I_1 (0.5 IW:CPE ratio), I_3 (0.9 IW:CPE ratio) and I_0 (control, irrigation at critical growth stages), respectively.

The increase in seed yield might be due to the increase irrigation frequency and consumptive use on account of increased ratio. Thus, there was progressive increased in seed yield due to favourable moisture condition and better availability of soil moisture at higher frequency of irrigation throughout the crop growth period which remarkably stimulated the yield attributing characters such as av. number of pods per plant, av. Pod length, av. number of seeds per pod and test weight.

Second reason might be the adequate supply of moisture favourably improved nutrient uptake and translocation which ultimately is linked with the growth and development. Beneficial effects of these parameters resulted in to higher seed yield. Other reason for increasing seed yield might be due to the fact that the crop receiving irrigation at early growth stage established its root system deep into the soil for better extraction of moisture from larger volume of soil.

In context to environmental condition, scheduling irrigation at 0.7 IW:CPE ratio provided with the optimum reproductive phase with larger photosynthetic green surface and reproductive storage

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capacity to attain higher allocation of dry matter to seed in moth bean. The results are supported by Vasimalai and Subramaniam (1980).

More cell division, synthesizing activity and assimilation rate leading to the increase in growth characters, yield attributes and ultimately the seed yield and gotar yield.

The lowest seed yield (319 kg/ha) was observed under treatment I₀ (control, irrigation at critical growth stages), which might be due to, under unsaturated soil moisture environment, a vapour gap would be formed round the roots by their turgor pressure under water stress. Such a gap if ever present would reduce the availability of nutrients to the roots probably due to lesser contact between roots and water partial causing drastic reduction in dry matter production and uptake of nutrients. A remarkable reduction in seed yield with limited water supply was explained on the basis of internal water status in relation to different physiological processes taking place in plant. The results are in agreement with Sarkar (1992), Tank *et al.* (1992), Trivadi *et al.* (1998), Dabhi *et al.* (2000) and Bhadoria and Bhadoria (2002) for green gram.

Dry gotar yield of summer moth bean was significantly influenced due to different irrigation scheduling (IW:CPE ratio). Among the different irrigation scheduling (IW:CPE ratio) the highest dry gotar yield (664 kg/ha) was observed under treatment I₂ (0.7 IW:CPE ratio), whereas, significantly the lowest dry gotar yield (560 kg/ha) was observed under treatment I₀ (control, irrigation at critical

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growth stages). The increase in dry gotar was mainly due to adequate moisture supply throughout the entire growth period which resulted into better growth and development and higher plant height, number of branches per plant. These growth components might have contributed towards higher gotar yield. Patel and Saraf (1999) reported that under IW:CPE ratio of 0.7 produced significantly higher straw yield of summer cow pea followed by 0.5, 0.9 IW:CPE ratio.

A remarkable reduction in dry gotar yield with limited water supply is explained on the basis of internal water status in relation to different physiological processes taking place in the plant. Based on the functional behaviour of water in relation to sole productive processes of photosynthesis taking place in plant. These findings are analogous with those reported by Vasimalai and Subramaniam (1980), Tank *et al.* (1992), Trivadi *et al.* (1998), Dabhi *et al.* (1998), Dabhi *et al.* (2000) and Bhadoria and Bhadoria (2002) for green gram.

The test weight was significantly influenced due to different irrigation scheduling (IW:CPE ratios). Treatment I₂ (0.7 IW: CPE ratio) recorded higher value of test weight (20.90g). While the lowest test weight (12.40g) was observed under treatment I₀ Control (Irrigation at critical growth stages). This might be due to the severe water stress occurred when the IW:CPE ratio become narrow. Water deficit during pod filling stage might have contributed towards the shriveled and wrinkled seed. Further, continuous pod formation and

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excess growth might have reduced the size of seed. The results are in conformity with those by Dhabi *et al.* (1998) for green gram.

5.3.4 EFFECT ON WATER USE

Total quantity of water applied were 250, 350, 450 and 550 mm with the depth of water of 50 mm under irrigation scheduling I_0 Control (Irrigation at critical growth stages), I_1 0.5 IW:CPE ratio, I_2 0.7 IW:CPE ratio and I_3 0.9 IW:CPE ratio. The highest consumptive use of water (558.3mm) was recorded under treatment I_3 (0.9 IW:CPE ratio), followed by I_2 (0.7 IW:CPE ratio, 452.5 mm), I_1 (0.5 IW:CPE ratio, 353.7 mm) and I_0 control (irrigation at critical growth stages, 250.8mm), respectively.

Thus, the consumptive use of water increased with increased with increase in the irrigation water quantity. This might be due to more number of irrigations with high quantity of water increased the consumptive use of water, due to better growth of crop and simultaneously the loss of water through evaporation owing to availability of wet regimes for longer period under latter scheduling. Inadequate moisture supply to the crop under I_0 : Control (Irrigation at critical growth stages) treatment resulted in lower CUW. These findings are analogous to those reported by and Soni and Gupta (1999) for green gram.

Other reason might be due to conductive effect of wet rhizosphere on maintenance of wet surface for longer period and consequently had led to higher losses through evaporation. Moreover, creation of higher vapour pressure gradient between canopy air and atmospheric air might be responsible for greater

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evapotranspiration from frequently irrigated plots. Patel *et al.* (2008).

Water use efficiency refers largely to the production of economic produce of crop per unit of water used by it throughout the life of a crop. Unlike consumptive use of water, the water use efficiency decrease with each successive increase in IW:CPE ratio (Table 4.15). The highest water use efficiency (1.270 Kg/ha-mm) was observed under irrigation at I₀ Control (Irrigation at critical growth stages). The lowest water use efficiency (0.70 Kg/ha-mm) recorded under treatment I₃ (0.9 IW:CPE ratio).

The probable reason might be due to irrigation scheduling (IW:CPE ratio) influenced the water status of the soil profile, evapotranspiration and water use efficiency. An increase in frequency of irrigation resulted in higher soil moisture content and greater ET. Frequent wetting of the upper soil layer exposed to the hot atmosphere under 0.9 IW:CPE ratio created a higher vapour pressure gradient between the crop canopy and the atmosphere, which might have caused relatively larger loss of water from the soil surface than in other schedules which resulted in lower water use efficiency. Soni and Gupta (1999) and Dabhi *et al.* (2000). The higher WUE under control treatment- critical growth stages was stemmed from less water loss due to evapotranspiration under limited water supply were observed by Tank *et al.* (1996), Bhadoria and Bhadoria (2002) for green gram.

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Moisture extraction pattern showed (Table 4.16) that the soil moisture extraction decreased progressively with depth of soil under all irrigation schedules (IW:CPE ratio). The moisture extracted from 0-15, 15-30, 30-45, and 45-60 cm of soil depth were 24.25, 19.40, 17.59 and 15.43 percent under treatment I_0 (control, irrigation at critical growth stages), 25.75, 19.00, 17.81 and 15.84 percent under treatment I_1 (0.5 IW:CPE ratio), 28.48, 20.20, 16.12 and 15.23 percent under treatment I_2 (0.7 IW:CPE ratio), 31.71, 21.50, 18.22 and 13.47 percent under treatment I_3 (0.9 IW:CPE ratio). The maximum percent of moisture was extracted from 0-15 cm soil depth, followed by 15-30 cm soil depth for all the treatments of irrigation (IW:CPE ratio). The moisture extraction increased with increase in quantity of irrigation water from upper soil layers (0-15 and 15-30 cm soil depth), where as, almost reverse trend was observed with respect to deeper soil layers (30-45 and 45-60 cm soil depth) under the study.

This might be due to the moisture extraction was increased with increase in frequency of the irrigation from upper soil layer and on the other hand, moisture extraction increased gradually with decrease in frequency of irrigation in deeper soil layer. Other reason might be due to the moisture extraction pattern under control (irrigation at critical growth stages) I_0 was relatively higher from the lower soil depth indicating higher activity of roots in the deeper soil layers under water stress. Moisture extraction increased with

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increase in the frequency of irrigation under first 0-30 cm soil depth, perhaps due to increase in the surface evaporation and water use. These findings are analogous to those reported by dewangan *et al.* (1993) and patel *et al.* (2008).

5.3.4.1 EFFECT ON QUALITY

Data pertaining to the effect of irrigation scheduling (IW:CPE ratios) on protein content (Table 4.13) was non-significant. This might be due to the genetic make up of particular cultivar. The results are in agreement with those reported by Soni and Gupta (1999) and Borse *et al.* (2002).

5.4 INTERACTION EFFECT OF DATE OF SOWING AND IRRIGATION SCHEDULING (IW:CPE RATIO)

Interaction effect between date of sowing and irrigation scheduling (IW:CPE ratios) was significant for seed yield, (Table 4.9), treatment combination D₂I₂, (30th January) date of sowing of moth bean with irrigation scheduling based on IW:CPE ratio 0.7 (9 irrigation) recorded significantly the highest seed yield (651 kg/ha). Significantly lower seed yield (303 kg/ha) was obtained under treatment combination D₂I₀ (30th January) date of sowing with irrigation scheduling based on critical growth stages being at par with treatment combination D₃I₀ (sowing at 9th February) and control (irrigation at critical growth stages) D₄I₀ (sowing at 19th February) and control (irrigation at critical growth stages) D₁I₀ (sowing at 20th January) and control (irrigation at critical growth stages) were remained at par with each others.

Discussion

The probable reason might be due to fact that all the growth and yield parameters were affected by date of sowing and irrigation scheduling (IW:CPE ratio). The highest seed yield would be obtained by sowing at 30th January with 9 irrigation (0.7 IW:CPE ratio). Where, the crop could avoid drought thereby completing pod filling early in the season before moisture stress becomes limiting. It also indicated that date of sowing and irrigation scheduling (IW:CPE ratio) did not only increase yield, but also allowed sowing date delayed without incurring seed yield loss.

If we considering date of sowing D₁ (20th January) late flowering came due to unfavourable high temperature and diseases and insects infection cause loss in seed yield. D₃ (9th February) and D₄ (19th February), delay in sowing during high temperature dry the stigma and spelt dropped the flower and ultimately less seed yield through 9 and 11 irrigation were given.

It is concluded that second date of sowing (D₂: 30th January) and irrigation I₂ (0.7 IW:CPE ratio, 9 irrigation) was found beneficial and conducive for the highest seed yield of summer season cultivation of moth bean under middle Gujarat.

5.5 EFFECT OF DATE OF SOWING AND IRRIGATION SCHEDULING (IW:CPE RATIO) ON ECONOMICS OF SUMMER MOTH BEAN

5.5.1 Effect of date of sowing

The highest gross (34663 Rs./ha) and net realization (21725 Rs./ha), CBR (2.68) and net CBR (1.68) was secured under treatment D₂ (Table 4.17) sowing at (30th January), While the lowest

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gross (27745 Rs./ha) and net realization (14807 Rs./ha), CBR (2.14) and net CBR (1.14) was observed under treatment D₁ sowing at (20th January). Similar findings were reported by Patel (1984), Singh *et al.* (1986) and Patel *et al.* (2004).

5.5.2

Effect of irrigation

scheduling (IW:CPE ratios)

The data pertaining to economics presented in table 4.17 indicated that the highest gross (35566 Rs./ha) and net realization (18128 Rs./ha), CBR (2.04) and net CBR (1.04) was secured under treatment I₂ (0.7 IW:CPE ratio). While the lowest gross (24065 Rs./ha) and net realization (8727 Rs./ha) was secured under treatment I₀ (control irrigation at critical growth stages), while the lowest CBR (1.50) and net CBR (0.50) was observed under treatment I₃ (0.9 IW:CPE ratio). Similar findings were reported by Dabhi *et al.* (2004).

SUMMARY AND CONCLUSION

A field experiment was conducted during summer season of the year 2010 at College Agronomy farm, B. A. College of Agriculture, Anand Agricultural University, Anand, Gujarat to study the “ **Influence of date of sowing and Irrigation scheduling (IW: CPE ratios) on growth, yield attributes and yield of summer moth bean (*Vigna acontifloia (Jacq.) Marechal*) under middle Gujarat conditions**”. There were sixteen treatment combinations, consisting of four date of sowing, D₁ (20th January) , D₂ (30th January), D₃ (9th February) and D₄ (19th February) and four levels of irrigation scheduling (IW:CPE ratios) viz., I₀- (Control irrigation at critical growth stages) at branching, at flowering, at pod formation, at grain formation, I₁ (0.5 IW: CPE ratio), I₂ (0.7 IW: CPE ratio), I₃ (0.9 IW: CPE ratio) were tested under strip plot design with four replications.

Each experimental unit was 3.60 m × 6.00 m and 2.40 m × 5.00 m in gross and net plot, respectively. The soil of the experimental plot was loamy sand in texture having good drainage, low in nitrogen, medium in available phosphorus and high in potash with soil p^H 7.5.

The weather conditions were favourable for normal growth of summer moth bean during the crop season. Sowing of the crop as per date of sowing and different irrigation treatments (IW:CPE ratio) were imposed after establishment of the crop. Irrigation water was applied to each treatment with

Summary & Conclusion

measured quantity of water with the help of 7.5 cm. Parshall Flume. The periodical observations on different growth parameters and yield attributes were recorded. The protein content in seed was also determined. The experimental results presented and discussed in the foregoing chapters are briefly summarized and concluded here.

6.1 EFFECT OF DATE OF SOWING

The different levels of date of sowing did not exert their significant influence on plant population at 15 DAS and at harvest. It was indicated that plant population was uniform throughout the field experimentation. The growths attributed, such as periodical plant height at 30 and 60 DAS and at harvest, were significant. Sowing of the crop at 30th January (D₂) recorded the highest plant height (10.00 cm, 19.50 cm and 27.05 cm at 30, 60 DAS and at harvest, respectively).

The yield attributes *viz.*, average number of pods per plant (37.81), average pod length (3.78), average number of seeds per pod (5.66) and test weight (19.20g) were significantly higher under treatment (D₂) sowing at 30th January. Sowing of the crop at 30th January (D₂) resulted in significantly minimum days to 50% flowering (29.25 days). While the maximum days to 50% flowering (34.06 days) was observed under the sowing of crop at 20th January (D₁).

The treatment D₄ (sowing at 19th February) significantly recorded the lowest days to maturity (81.44 days). Significantly the

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highest days to maturity (105.06 days) was observed under treatment D₁ sowing at (20th January).

Significantly higher average number of pods (37.81) per plant was recorded under treatment D₂ sowing at (30th January). Whereas, the lowest number of pods per plant (32.75) was observed under treatment D₁ sowing at (20th January). Sowing at 30th January (D₂) recorded significantly higher average length of pod (3.78 cm), While lower average length of pod (3.57 cm) was observed under treatment D₁ sowing at (20th January).

Significantly higher seed yield (460 kg/ha) was recorded under treatment D₂ sowing at (30th January). Treatment D₂ sowing at (30th January) recorded higher seed yield to the tune of 18.26%, 19.78% and 20% over the treatments D₃ sowing at (9th February), D₄ sowing at (19th February) and D₁ sowing at (20th January), respectively.

Significantly higher dry gotar yield (653 kg/ha) and harvest index (40.70%) were recorded under treatment D₂ sowing at (30th January), Whereas, significantly the lowest dry gotar yield (578 kg/ha) was observed under treatment D₁ sowing at (20th January). The maximum mean consumptive use of water (408.5mm) and water use efficiency (1.170 Kg/ha-mm) was noticed under treatment D₂ sowing at (30th January). The highest gross (34663 Rs./ha) and net realization (21725 Rs./ha), CBR (2.68) and net CBR (1.68) was secured under treatment D₂ sowing at (30th January), While the lowest gross (27745 Rs./ha) and net realization (14807 Rs. per hectare), CBR (2.14) and net CBR (1.14) was found under treatment D₁ sowing at (20th January).

Summary & Conclusion

6.2 EFFECT OF IRRIGATION SCHEDULING (IW:CPE RATIOS)

The different levels of irrigation scheduling (IW:CPE ratios) did not exert their significant influence on plant population at 15 DAS and at harvest. It was indicated that plant population was uniform.

Treatment I₂ (0.7 IW:CPE ratio) recorded significantly the highest average plant height (11.37, 19.76, 27.95 cm) at 30 and 60 DAS and at harvest. Treatment I₃ (0.9 IW:CPE ratio) and I₁ (0.5 IW:CPE ratio) were remained at par with each others.

Significantly the highest days to 50% flowering (34.44 days) was observed under treatment I₃ (0.9 IW:CPE ratio). While the minimum days to 50% flowering (29.56) was observed under the treatment I₀ (control, irrigation at critical growth stages), which was remained at par with treatment I₁ (0.5 IW:CPE ratio).

The treatment I₀ (control, irrigation at critical growth stages) recorded significantly minimum days to maturity (89.31). Whereas, the maximum days to maturity (94.44 days) were recorded by treatment I₃ (0.9 IW:CPE ratio), which was remained at par with treatment I₂ (0.7 IW:CPE ratio). Treatment I₂ (0.7 IW:CPE ratio) recorded significantly higher (3.94 cm) average length of pod, number of pods per plant (37.53), number of seeds per pod (5.66) when irrigation was applied at 0.7 IW:CPE ratio.

Significantly the highest (472 & 664 kg/ha) seed and dry gotar yield were observed under treatment I₂ (0.7 IW:CPE ratio), respectively. Whereas, significantly the lowest seed (319 kg/ha) and dry gotar yield (560 kg/ha) were observed under treatment I₀

Summary & Conclusion

(control, irrigation at critical growth stages). Treatment I_2 (0.7 IW:CPE ratio) recorded higher seed yield at the extent of 16.73%, 17.58%, and 32.41% over the treatments I_1 (0.5 IW:CPE ratio), I_3 (0.9 IW:CPE ratio) and I_0 (control, irrigation at critical growth stages), respectively.

The treatment I_2 (0.7 IW: CPE ratio) recorded higher test weight (20.90g) and harvest index (41.15%). when irrigation was applied at 0.7 IW:CPE ratio. The protein content was non significantly influenced due to different irrigation treatment. The maximum mean consumptive use of water (558.3 mm) was recorded under treatment I_3 (0.9 IW:CPE ratio). The maximum WUE (1.270 kg/ha-mm) was obtained under treatment I_0 (control, irrigation at critical growth stages).

The highest gross (35566 Rs./ha) and net realization (18128 Rs./ha), CBR (2.04) and net CBR (1.04) was secured under treatment I_2 (0.7 IW:CPE ratio). While the lowest gross realization (24065 Rs./ha), net realization (8727 Rs./ha) was obtained under treatment I_0 (control irrigation at critical growth stages), while lowest CBR (1.50) and net ICBR (0.50) was observed under treatment I_3 .

6.3 INTERACTION EFFECT BETWEEN DATE OF SOWING AND IRRIGATION SCHEDULING (IW:CPE RATIO)

Treatment combinations (D_2I_2), 30th January date of sowing of with irrigation scheduling based on IW:CPE ratio 0.7 (9 irrigation) recorded significantly the highest seed yield (651 kg/ha). Significantly lower seed yield (303 kg/ha) was obtained under

Summary & Conclusion

treatment combinations D₂I₀, (30th January date of sowing with irrigation scheduling based on critical growth stages) being at par with treatment combination D₃I₀, (sowing at 9th February and control, irrigation at critical growth stages), D₄I₀ (sowing at 19th February and control, irrigation at critical growth stages), D₁I₀ (sowing at 20th January and control, irrigation at critical growth stages) were remained at par with each others.

CONCLUSION

For securing higher seed yield and net realization from summer moth bean crop Cv. RMO-225 raised on loamy sand soil of middle Gujarat, it is advisable that crop should be sown at 30th January with nine irrigations, each of 50 mm depth scheduled at an IW:CPE ratio of 0.7. The common irrigation should be applied immediately after dry sowing, first irrigation at fourteen days after common irrigation and second at also fourteen days after first irrigation and remaining six irrigations should be applied at an interval of seven to ten days.

FUTURE LINE OF WORK

The following suggestions are made for the future line of research work on the basis of present findings.

1. The experiment should be repeated for two to three times for evaluating consistency and applicability of the treatments to arrive at conclusive recommendations.

Summary & Conclusion

2. In order to have general recommendation, the same experiment should be conducted in various agro climatic zone of Gujarat.
3. The irrigation scheduled based on at critical growth stages under limited water supply should be study.
4. Other moth bean cultivars should be also tested.

APPENDIX - I

COST OF CULTIVATION OF MOTH BEAN

(A) Details of operational cost

Sr. No.	Particulars	Cost (Rs./ha)
A.	Land preparation	
1	Tractor cultivation (3 hrs) @ Rs. 200/hrs	600
2	Harrowing and planking (1 PB, 1 L)	600
B.	Seed rate 15 kg/ha, (Rs. 50/kg)	750
C.	Sowing	
1	Opening of furrows for fertilizer application (1PB +4 L)	900
2	Preparation of beds and irrigation channels (6 L)	600
3	Cost of sowing (12 L)	1200
4	Fertilizer Application	
	Nitrogen @ 20 kg/ha, Rs. 5.5 /kg from urea (11kg)	61
	Phosphorus @ 40 kg/ha, Rs. 10/ kg from DAP (87kg)	870
5	Common irrigation (one + 1 L)	600
D.	After- care operations	
1	Hand weeding two times (20 L)	2000
2	Thinning and gap filling (4 L)	400
3	Hand hoeing (2 L)	200
E.	Plant protection measures	
1	a) Endosulfan (1 lit./ha) (1L) @ Rs. 250/lit	900
	b) Monocrotophos (1.5 lit/ha) (1L) @ Rs. 300/lit	
F.	Harvesting (20 L)	2000
G.	Threshing and cleaning of grains (5 L)	500
H.	Land revenue	75
	Total cost of cultivation	12256
I	3 % interest on capital invested for 3 month (12%interest/year)	367
J	2.5 % supervision charge for 3 month (10% supervision charge /year)	315
	Total common cost (Rs.)	12938

Note:

PB : Pair of Bullock @ Rs. 500/ha

L : Labour @ Rs. 100/day

Appendices II- Total cost incurred for different levels of irrigation

Treatment	Number of	Labor	Applicati	Total cost
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Appendices

	irrigation		on charges (Rs./ha)	of treatment (Rs./ha)
Irrigation levels (I)				
l_0	4	4	400	2400
l_1	6	6	600	3600
l_2	8	8	800	4800
l_3	10	10	1000	6000

Appendices

Appendices IV Analysis of variance of growth and yield attributes, yield and quality

Source of variation	DF	Mean sum of square						
		Plant population		Plant height			50 % flowering	Maturity
		At 15 DAS	At harvest	At 30 DAS	At 60 DAS	At harvest		
Replication	3	25.136	26.527	0.824	1.790	0.986	0.750	2.188
D	3	51.290	29.832	39.632	31.302	97.839	76.208	1665.104
Error (a)	9	18.186	10.823	2.035	1.681	1.903	2.014	10.285
I	3	4.030	35.075	1.270	11.144	29.898	67.375	76.563
Error (b)	9	3.589	20.060	2.323	1.634	6.928	4.014	9.521
D X I	9	3.715	16.873	0.903	1.814	0.611	1.139	2.660
Error (c)	27	7.323	16.177	0.827	2.017	2.645	2.463	13.711

Appendices**.....Contid.**

Source of variation	DF	Mean sum of square					
		Length of pod	Number of pods/plant	Number of Seeds/pod	Test weight	Seed yield	Dry gotar yield
Replication	3	0.0464	5.543	0.0241	0.0073	2035.68	2256.31
D	3	0.1358	72.992	0.8893	0.0969	32364.43	16003.02
Error (a)	9	0.0309	3.464	0.1284	0.0174	1039.00	3923.53
I	3	0.8415	24.185	0.6883	2.5303	62185.22	28841.14
Error (b)	9	0.1367	5.290	0.0844	0.0164	2677.96	2361.54
D X I	9	0.0271	2.162	0.0292	0.0397	12765.54	5642.70
Error (c)	27	0.0687	5.821	0.1124	0.0194	1444.54	3484.14

Appendices

.....Contid.

Source of variation	DF	Mean sum of square	
		Harvest index	Protein content
Replication	3	9.351	2.1238
D	3	28.178	1.4738
Error (a)	9	4.633	1.1608
I	3	63.256	1.9334
Error (b)	9	9.195	1.6643
D X I	9	10.631	0.2009
Error (c)	27	7.236	1.3076

Appendices III-Total cost incurred for different treatment combinations

Treat-ment	Seed Yield (Kg/ha)	Dry gotat Yield (Kg/ha)	Gross realization (Rs./ha)	Cost of treat-ment (Rs/ha)	Common cost of cultivation (Including sowing cost)* (Rs/ha)	Total cost of cultivation (5+6) (Rs/ha)	Net realization (Rs/ha)	CBR	Net CBR
1	2	3	4	5	6	7	8	9	10
D ₁ l ₀	330	535	24846	2400	12938	15338	9508	1.62	0.62
D ₁ l ₁	376	591	28310	3600	12938	16538	11772	1.71	0.71
D ₁ l ₂	406	615	30604	4800	12938	17738	12866	1.73	0.73
D ₁ l ₃	360	571	27143	6000	12938	18938	8205	1.43	0.43
D ₂ l ₀	303	545	22880	2400	12938	15338	7542	1.49	0.49
D ₂ l ₁	421	627	31732	3600	12938	16538	15194	1.92	0.92
D ₂ l ₂	651	775	49000	4800	12938	17738	31262	2.76	1.76
D ₂ l ₃	467	665	35172	6000	12938	18938	16234	1.86	0.86
D ₃ l ₀	319	600	24094	2400	12938	15338	8756	1.57	0.57
D ₃ l ₁	389	630	29314	3600	12938	16538	12776	1.77	0.77
D ₃ l ₂	430	636	32428	4800	12938	17738	14690	1.83	0.83
D ₃ l ₃	364	601	27450	6000	12938	18938	8512	1.45	0.45
D ₄ l ₀	325	562	24478	2400	12938	15338	9140	1.60	0.60
D ₄ l ₁	389	610	29290	3600	12938	16538	12752	1.77	0.77
D ₄ l ₂	400	631	30120	4800	12938	17738	12382	1.70	0.70
D ₄ l ₃	363	600	27394	6000	12938	18938	8456	1.45	0.45

*Total common cost (Rs/ha) including sowing cost (Rs.1200/ha)
 Sale price- Seed - Rs. 75/kg, Dry gotar- 0.25kg/ha

List of correction suggested by the external referee Dr. K.V. Jadhav Junagadh

Point			Mistake/error/comment	Correction
Page No.	Para No./ Table No.	Line No./ Co. No.		
INTRODUCTION				
4	1	10	Missing (Sarkar <i>et al.</i> 1997)	Added in reference
REVIEWS OF LITERATURE				
7	1	4	Suggestion:- Write one paragraph of reviews -No research reviews available for moth bean, same family & same growth habit crop reviews are necessary to incorporate in this chapter.	One paragraph included as per suggestion
MATERIAL AND METHODS				
28	3.4	5, 7, 9	Insert "fallow"	Added as per suggestion
Aft.-30			Treatments allocation is made as per suggestion	It is corrected in replication one
31	3.6	8	Date mention as per 15 DAS	Added as per suggestion
EXPERIMENTAL RESULTS				
45	1	1	Remove levels of	Removed
48	1	1	Add as per suggestion	Added
60	2	1 to 4	Remove and put in discussion chapter	It is deleted & kept in discussion chapter
74	1	2, 5	Remove "incremental" 1-3	Removed. I, II, III
Discussion				
In discussion chapter remove all a, b, c, which is behind the year of review				
95	2, 3	6	Singh <i>et al.</i> (1984) year delete	(1986) is inserted
Summary and conclusion				
99	4	1	Remove "Rs."	Removed

REFERENCES				
I			Borah, H.K. (1998).	Borah, H.K. (1997).
iv			Prajapati, M. N.; Patel, J. J. and Gedia, K. M. (206 & 07).	Prajapati, M. N.; Patel, J. J. and Gedia, K. M. (2007).
37	3.8		Missing (Richard, 1948)	Added in reference
80	4	4	Missing (Ram and Dixit 2001)	Added in reference
84	2	2	Missing (Khan <i>et at.</i> 2000)	Added in reference
93	3	4	Missing (Borse <i>et al.</i> 2002)	Added in reference

Thesis viva- voce examination advisory committee members

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1.	Dr. J. J. Patel Professor of Agronomy B. A. Collage of Agriculture, Anand Agricultural University, Anand	(Guide)
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3.	Dr. M. N. Vyas Retd., Assoc. Professor of Agronomy. Junagadh	(External member)

Table
3.1

Month & Years	Met. Std. Week	Dates	Temp. (°C)		Bright Sunshine (Hrs/day) (BSS)	Evaporation (mm)	Ave. Relative Humidity (%)
			Max.	Min.			
Jan. 2010	1	01-07	27.5	11.1	7.0	3.3	65.7
	2	08-14	27.8	12.5	9.0	3.5	58.2
	3	15-21	28.1	11.6	8.9	3.6	59.0
	4	22-28	30.7	11.8	9.9	3.7	58.7
	5	29-04	29.9	13.3	9.0	3.6	60.0
Feb, 2010	6	05-11	31.0	16.2	7.6	5.2	58.8
	7	12-18	30.2	12.5	9.8	5.1	49.9
	8	19-25	32.5	14.8	9.1	5.1	47.4
	9	26-04	34.9	16.6	9.6	5.6	49.5
March, 2010	10	05-11	34.4	18.8	8.8	7.3	44.6
	11	12-18	38.1	17.3	9.6	6.9	43.6
	12	19-25	39.8	19.3	9.2	7.6	45.9
	13	26-01	37.2	20.8	9.4	7.8	51.9
April, 2010	14	02-08	38.6	21.6	9.6	9.4	43.3
	15	09-15	39.5	22.9	7.2	8.7	54.9
	16	16-22	40.8	24.6	10.2	9.2	55.4
	17	23-29	41.1	23.1	11.1	11.7	39.9

Meteorological data recorded during the course of investigation of 2010 (Weekly Mean)

Days to 50 % flowering

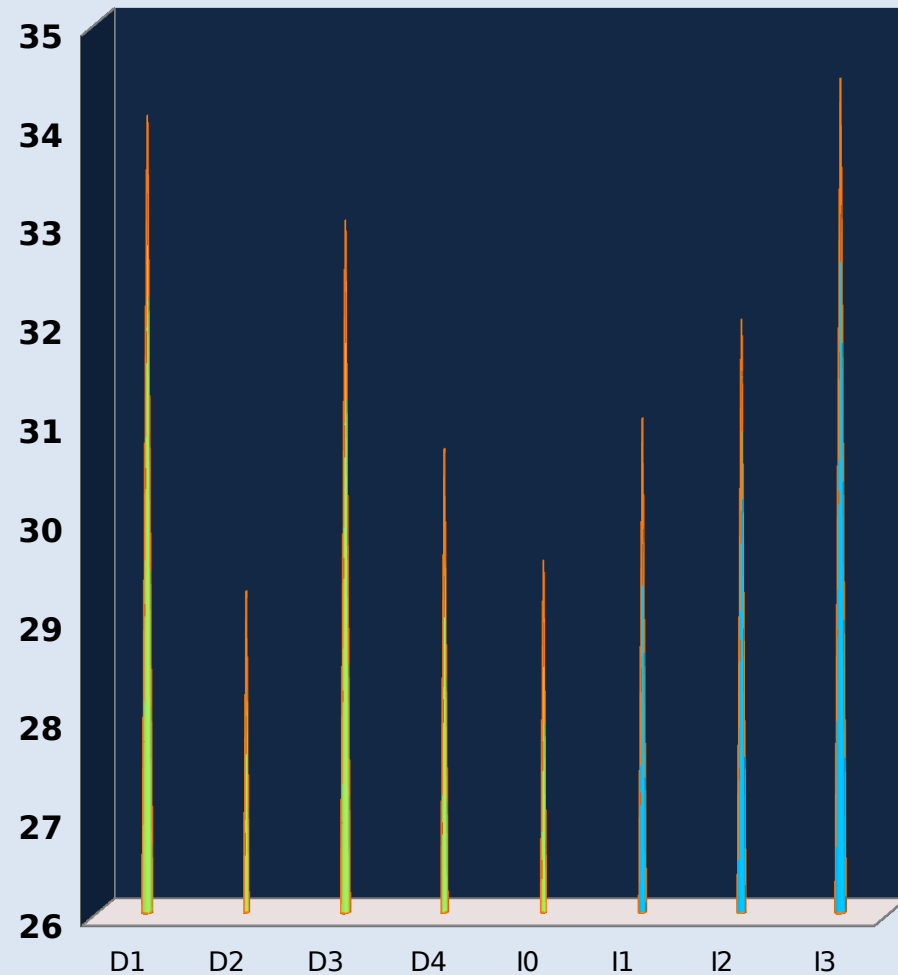


Fig. 4.2 Effect of date of sowing and irrigation scheduling (IW:CPE ratios) on days to 50 % flowering.

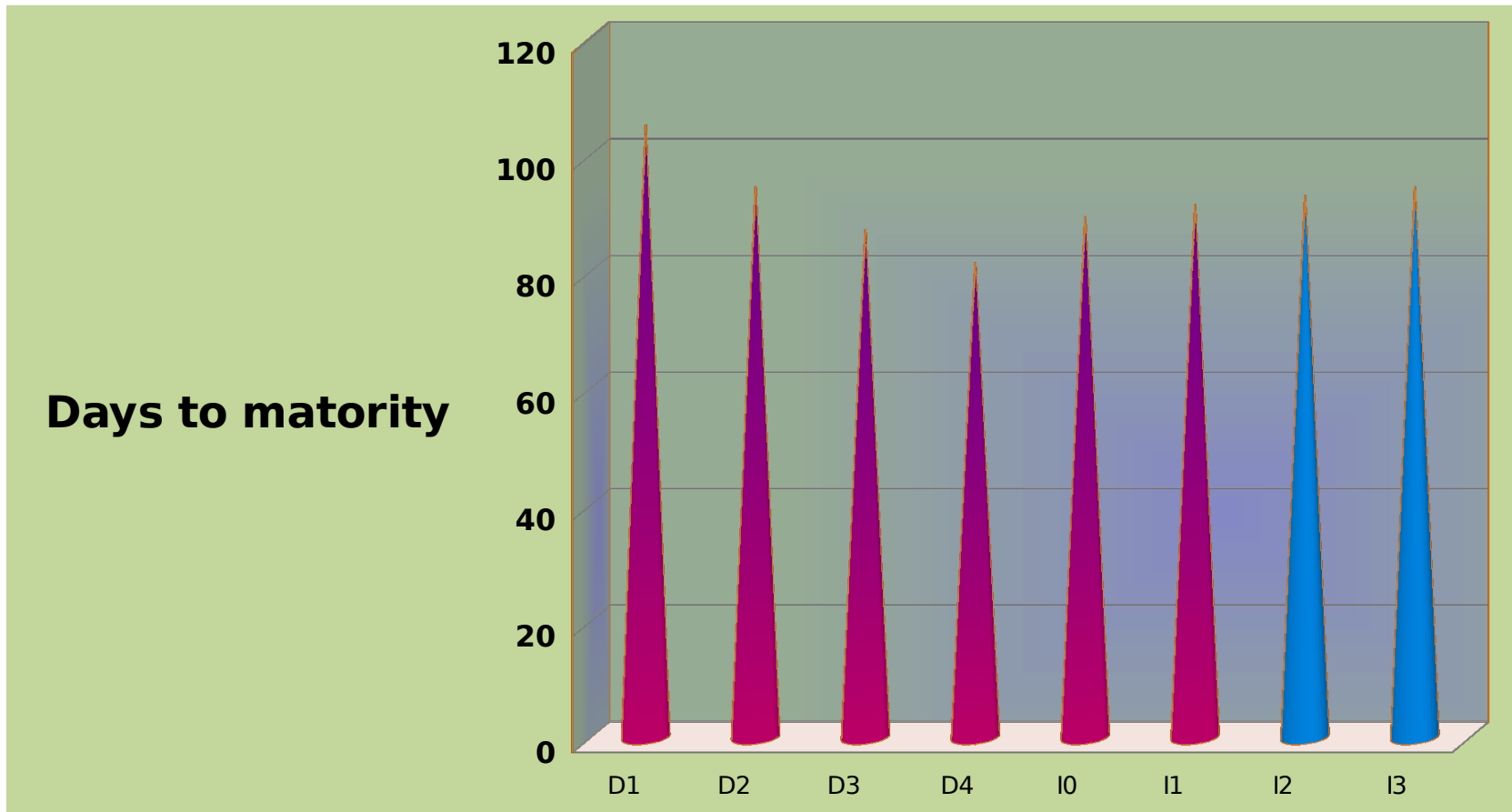


Fig. 4.3 Effect of date of sowing and irrigation scheduling (IW:CD ratios) on Maturity

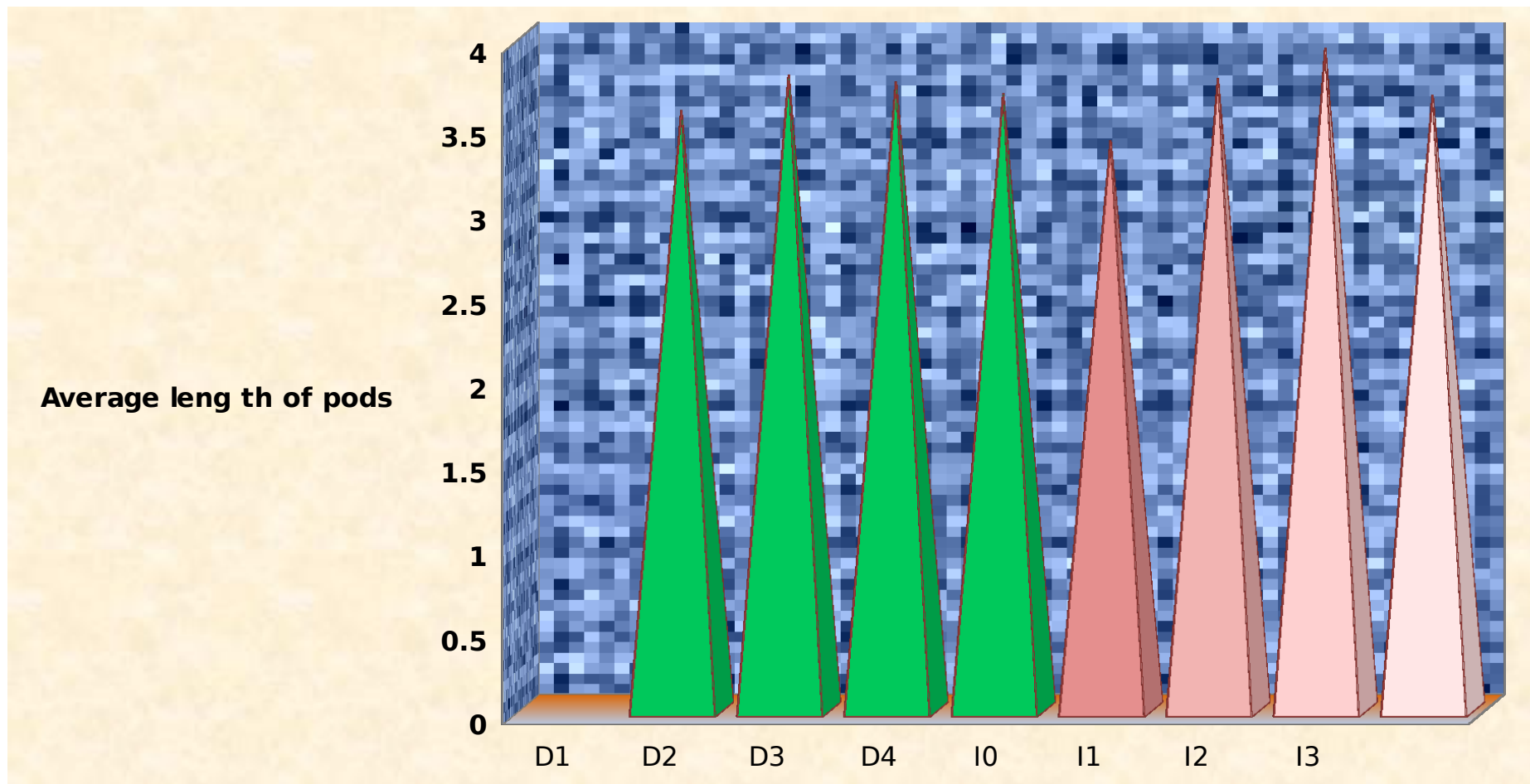


Fig. 4.4 Effect of date of sowing and irrigation scheduling (IW:CPE ratios) on Average

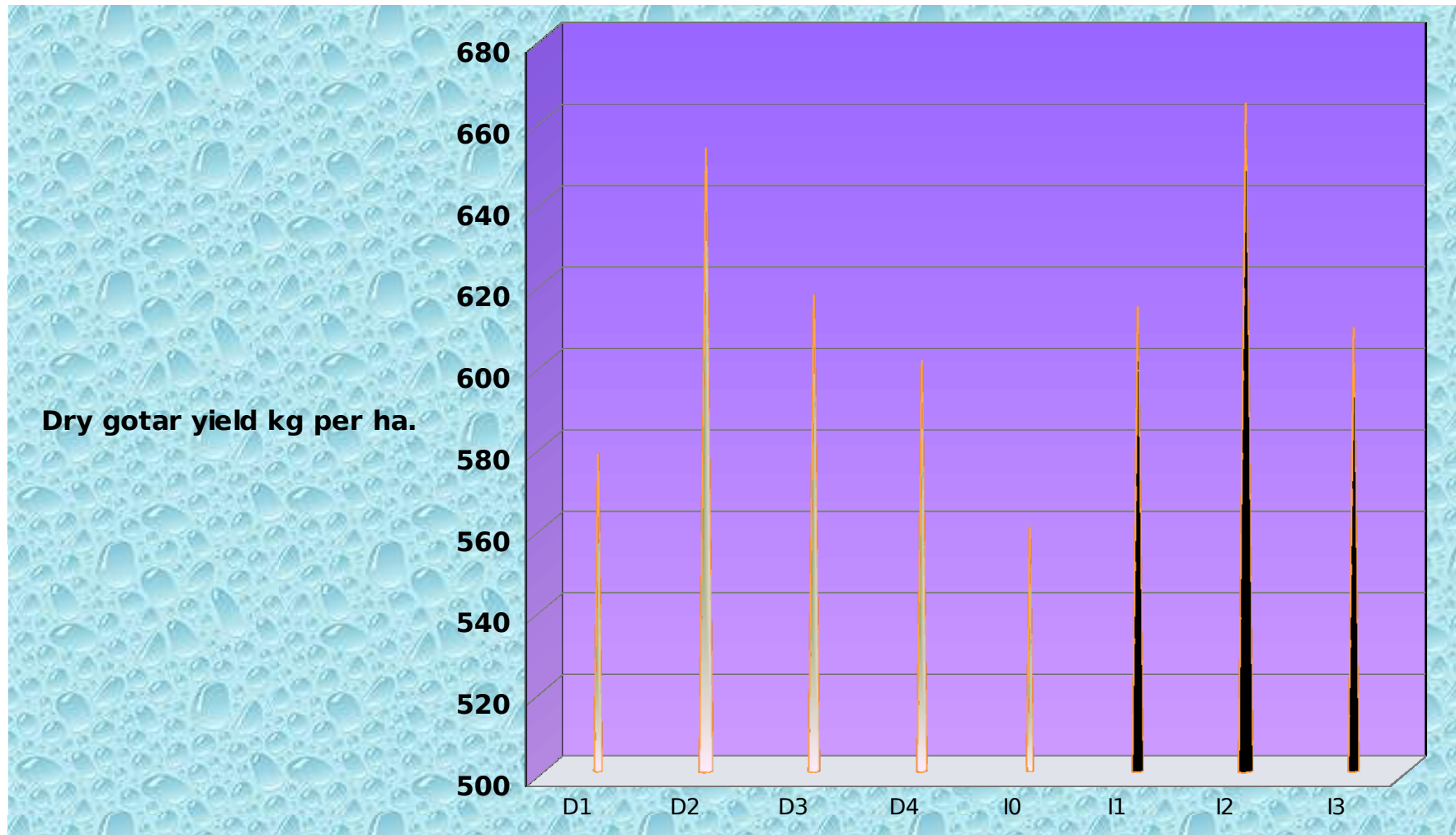


Fig. 4.7 Effect of date of sowing and irrigation scheduling (IW:CPE ratios) on dry
 water yield

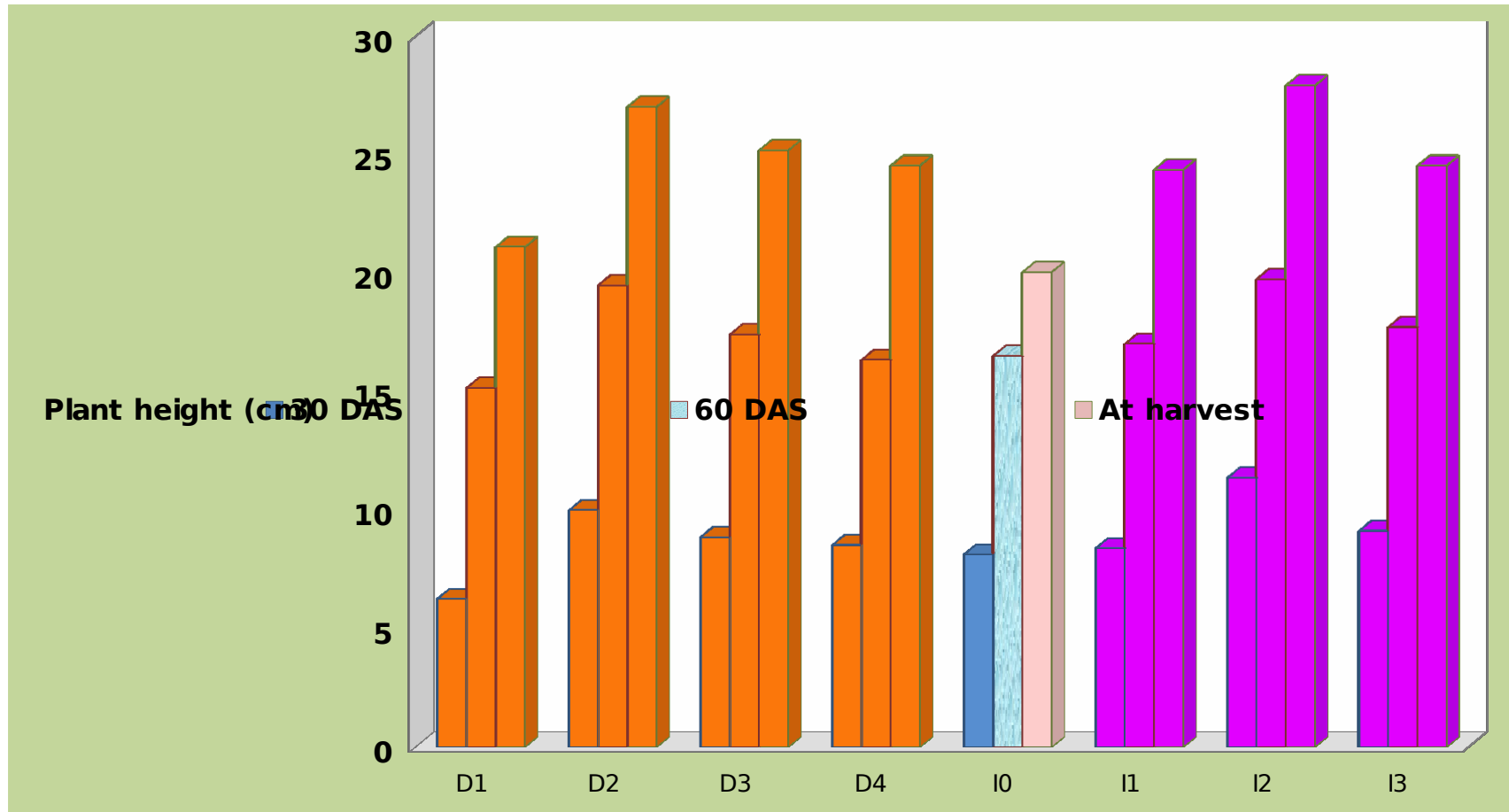


Fig. 4.1 Effect of date of sowing and irrigation scheduling (IW:CPE ratio) on plant height at 30, 60, and at harvest.

Fig. 4.10 Interaction effects of irrigation schedules based on critical growth stages and levels of

Seed yield (kg/ha)

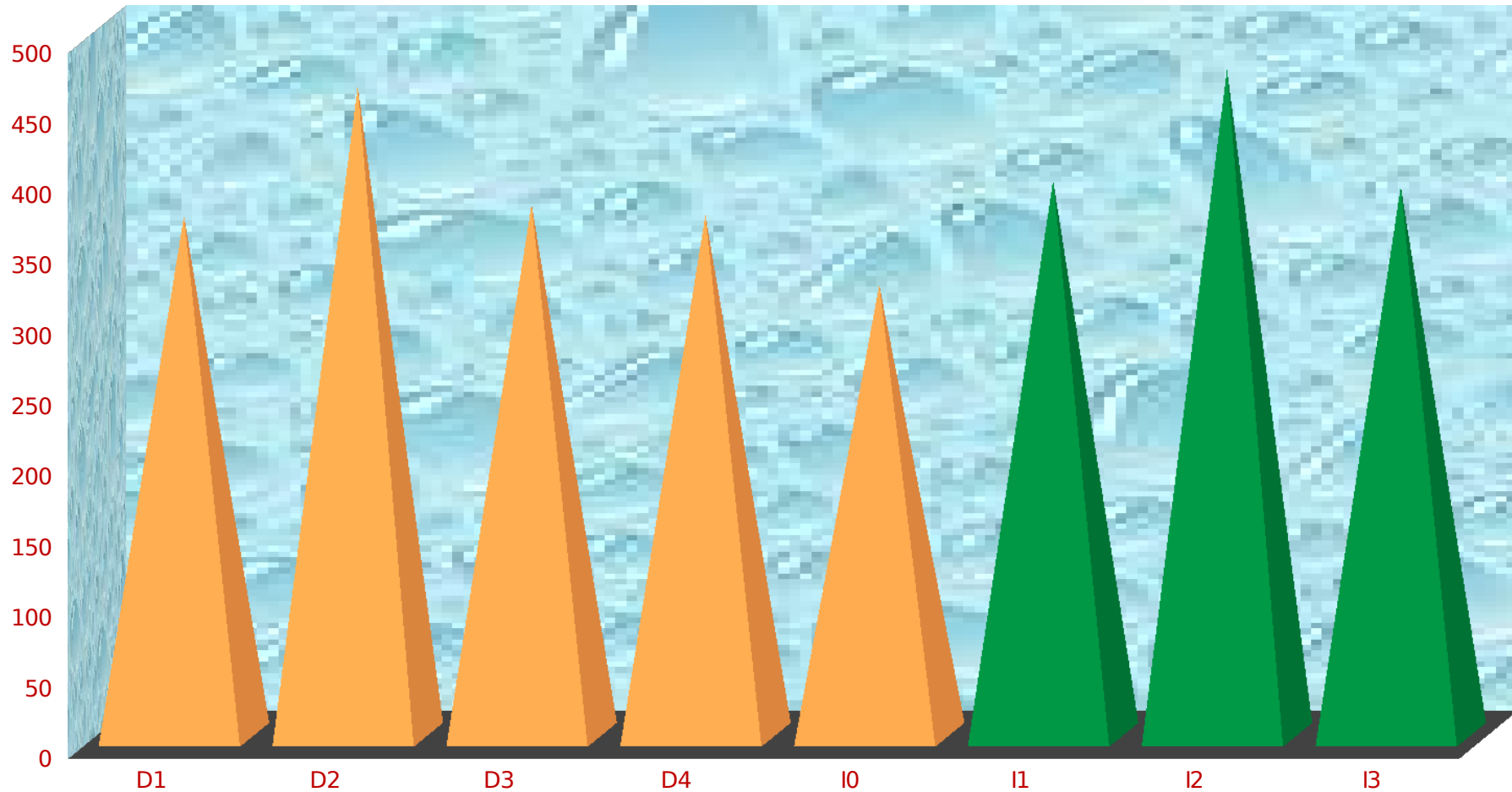


Fig. 4.6 Effect of date of sowing and irrigation scheduling (IW:CPE ratios) on seed yield.

Mean WUE (kg/ha-mm)

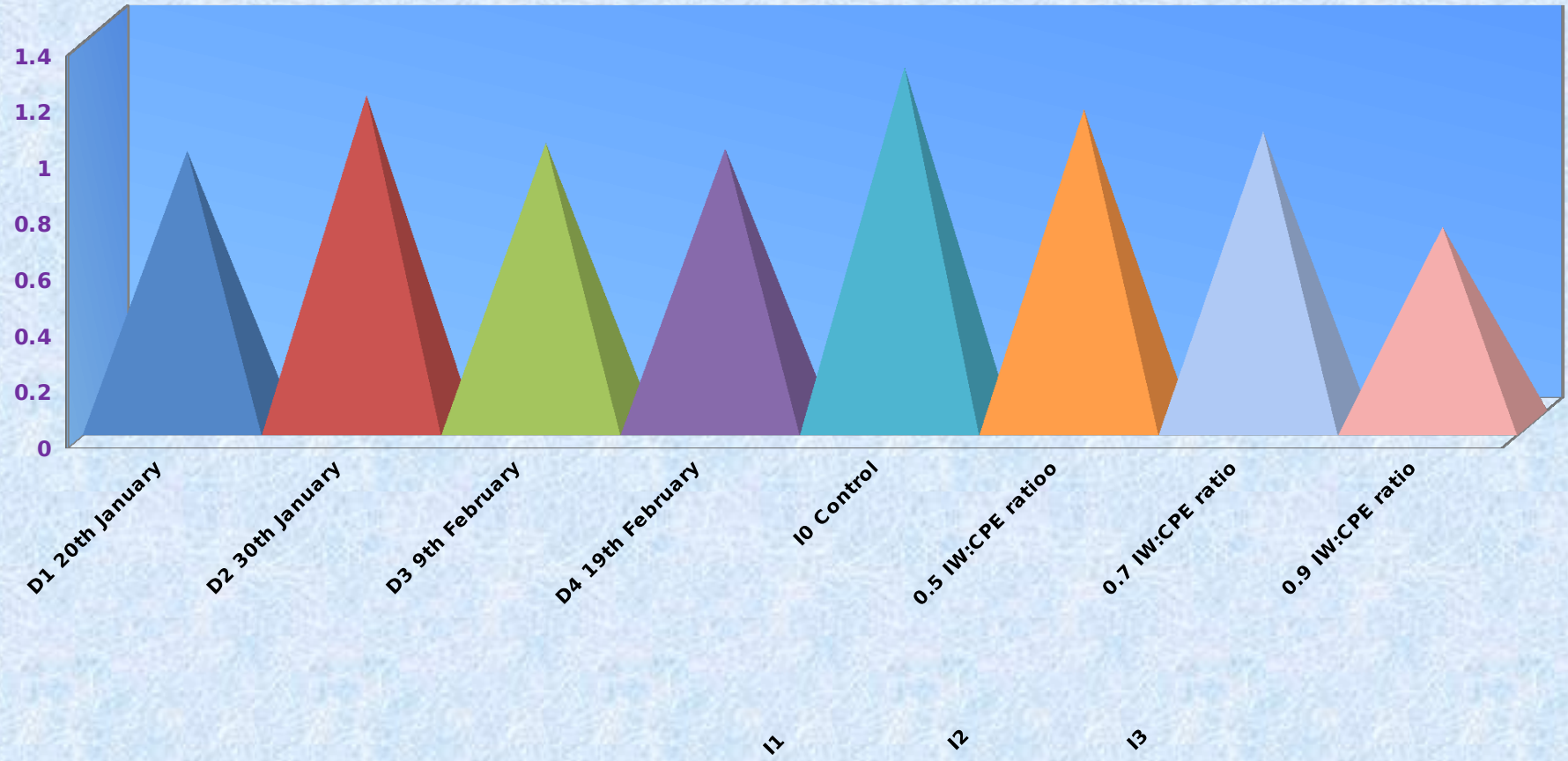


Fig: 4.10 Water use efficiency influenced by date of sowing and irrigation scheduling (IW:CPE ratios)

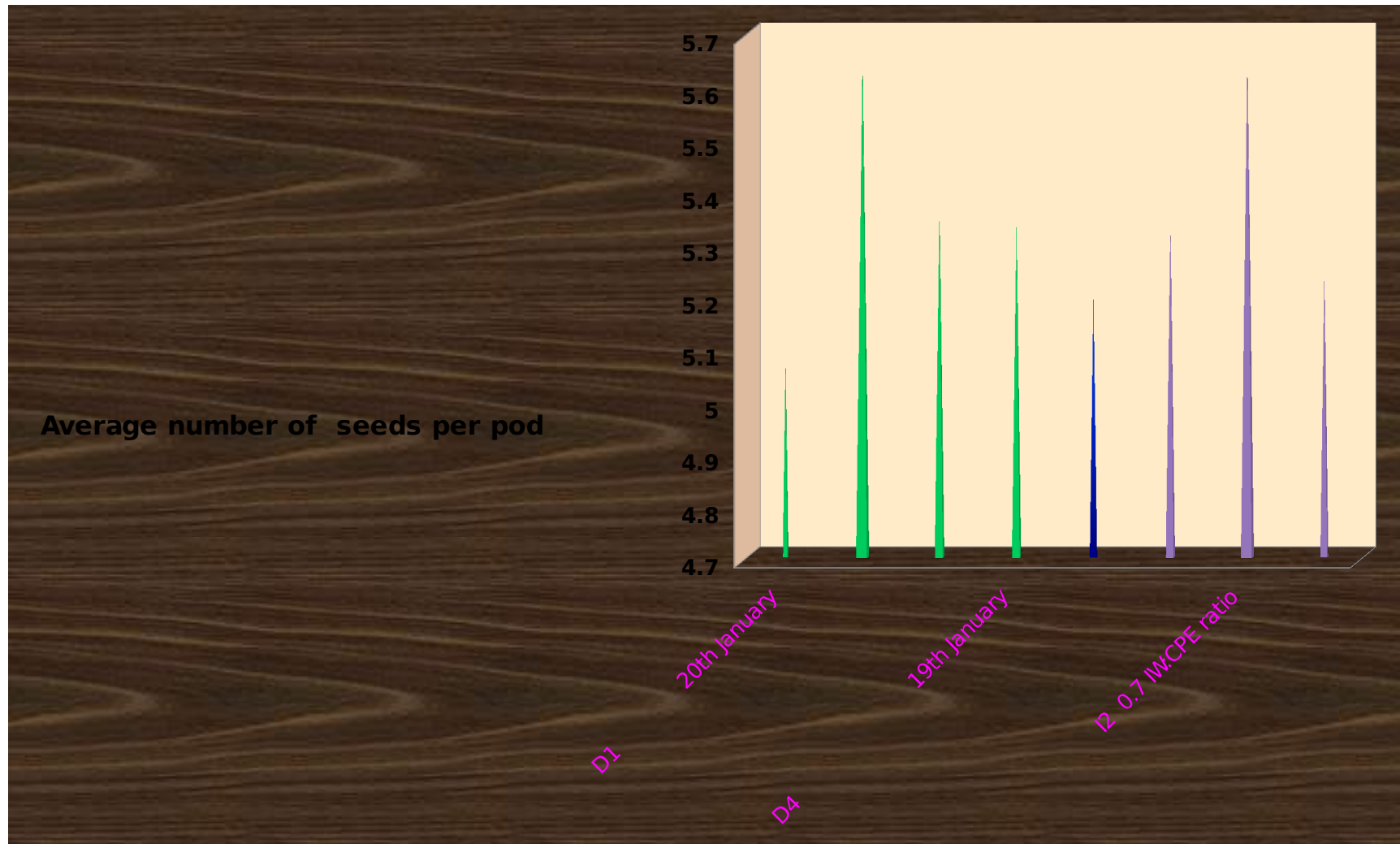


Fig: 4.5 Average number of seeds per pod influenced by date of sowing and irrigation scheduling (IW:CPE ratios)

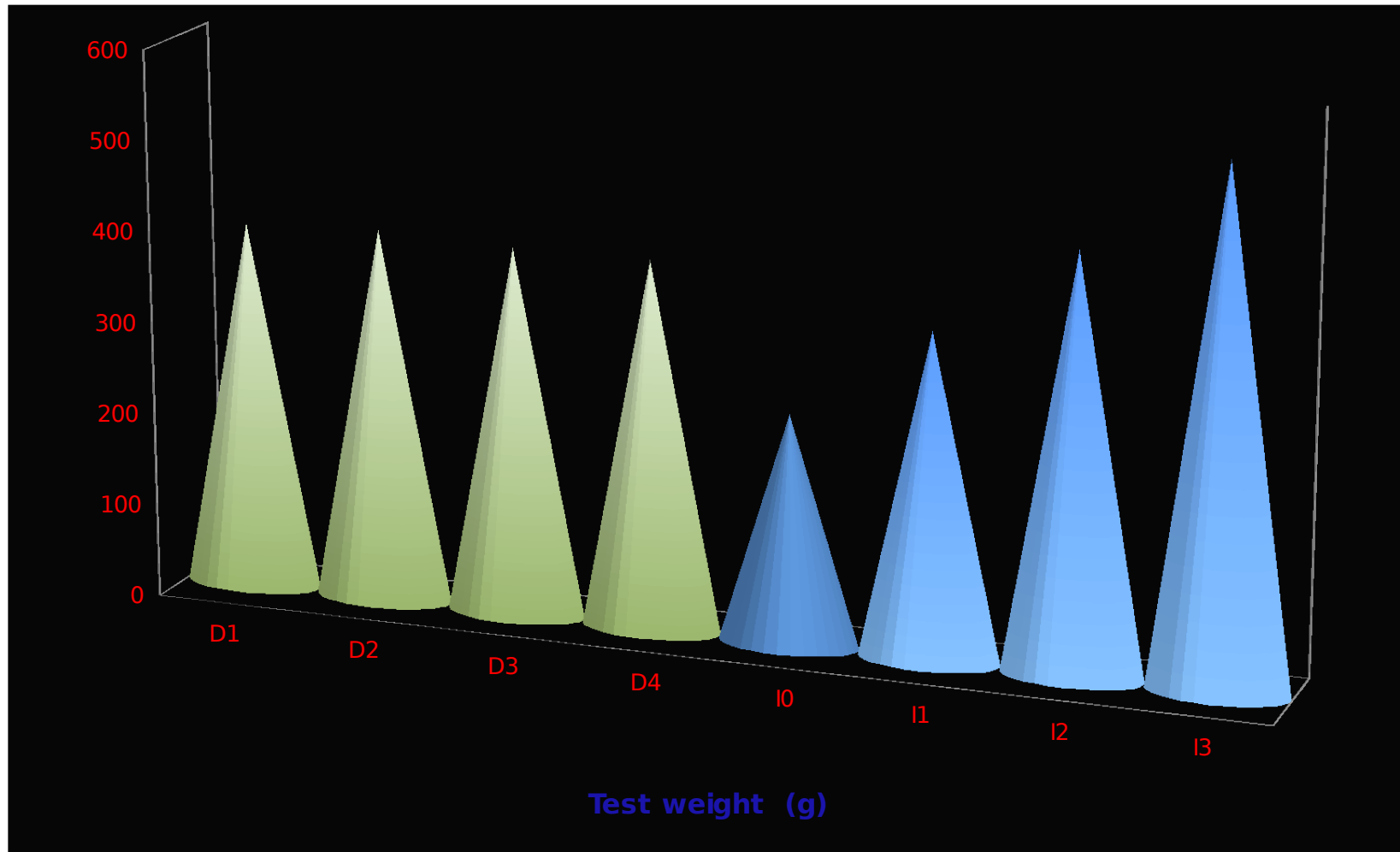


Fig- 4.8 Effect of date of sowing and irrigation scheduling (IW:CPE ratios) on test weight

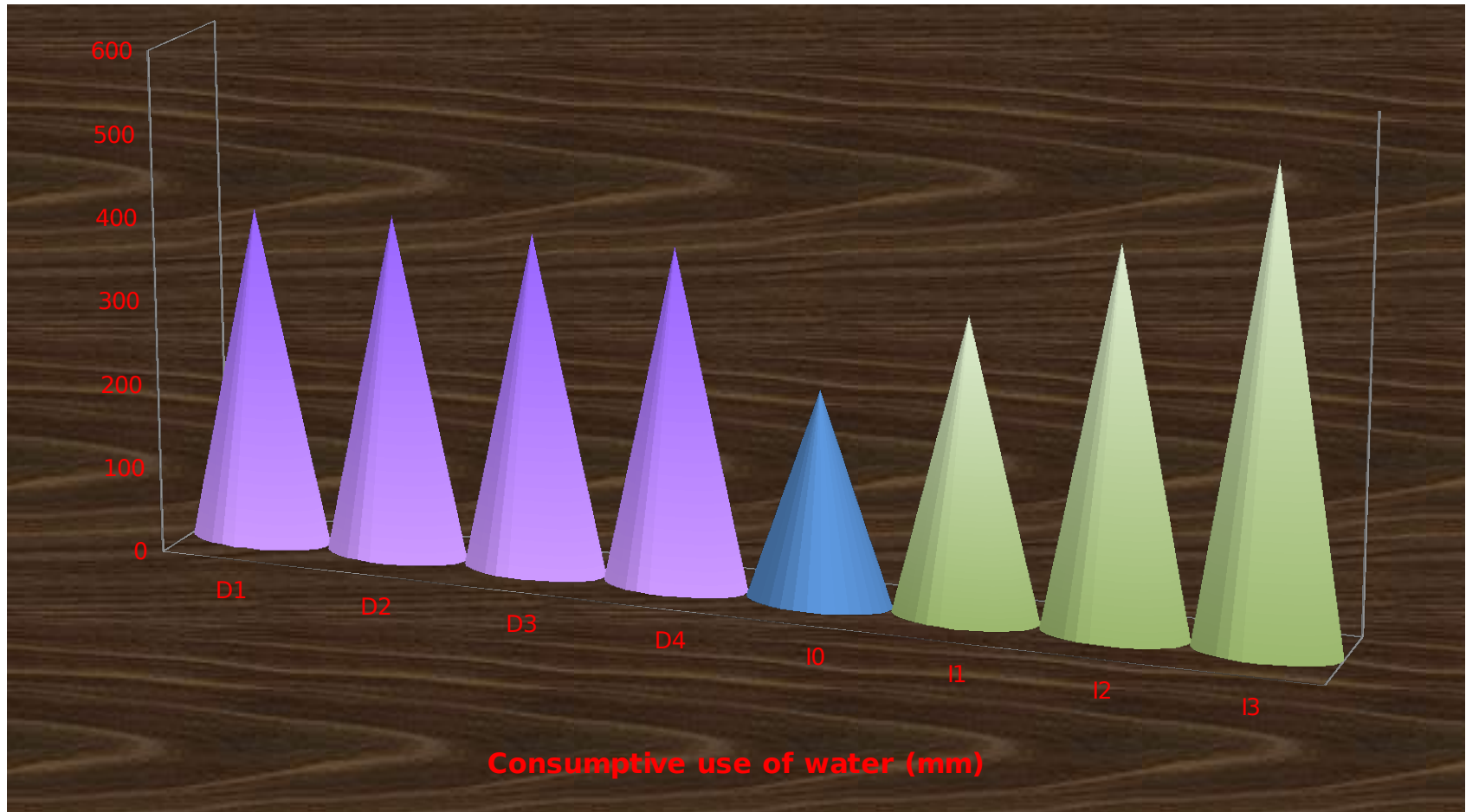
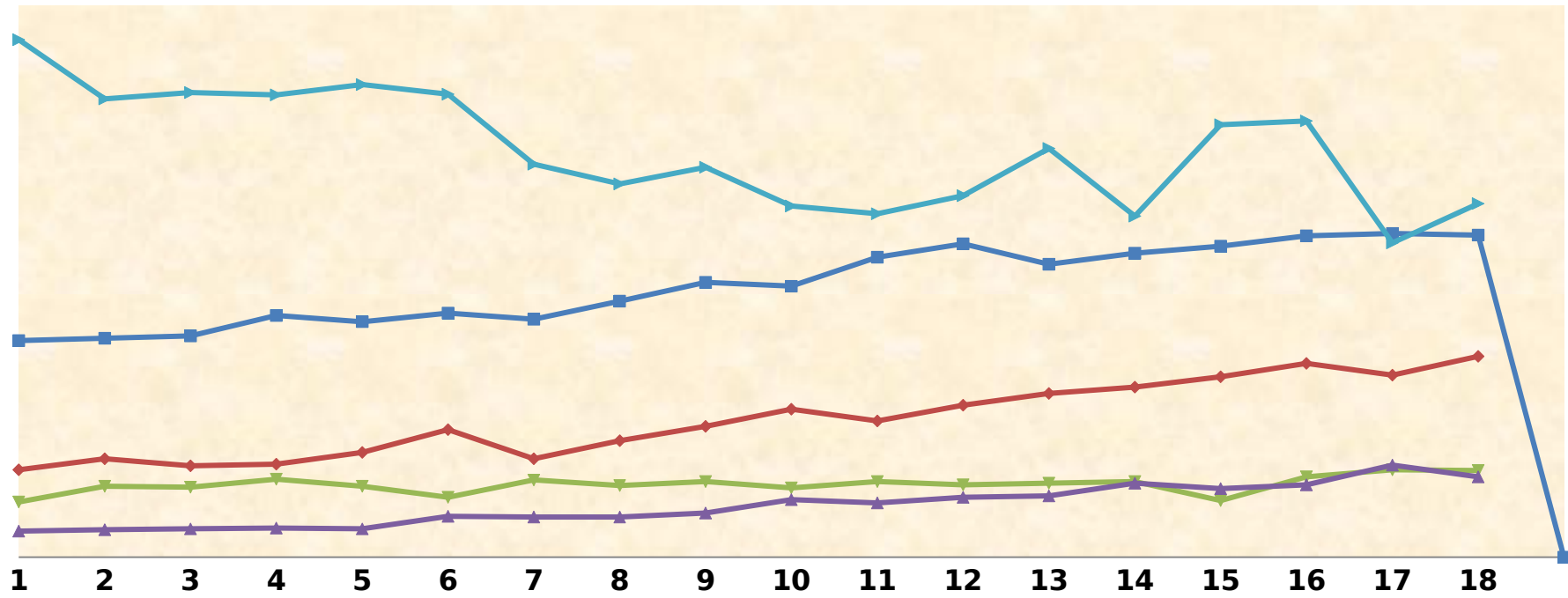


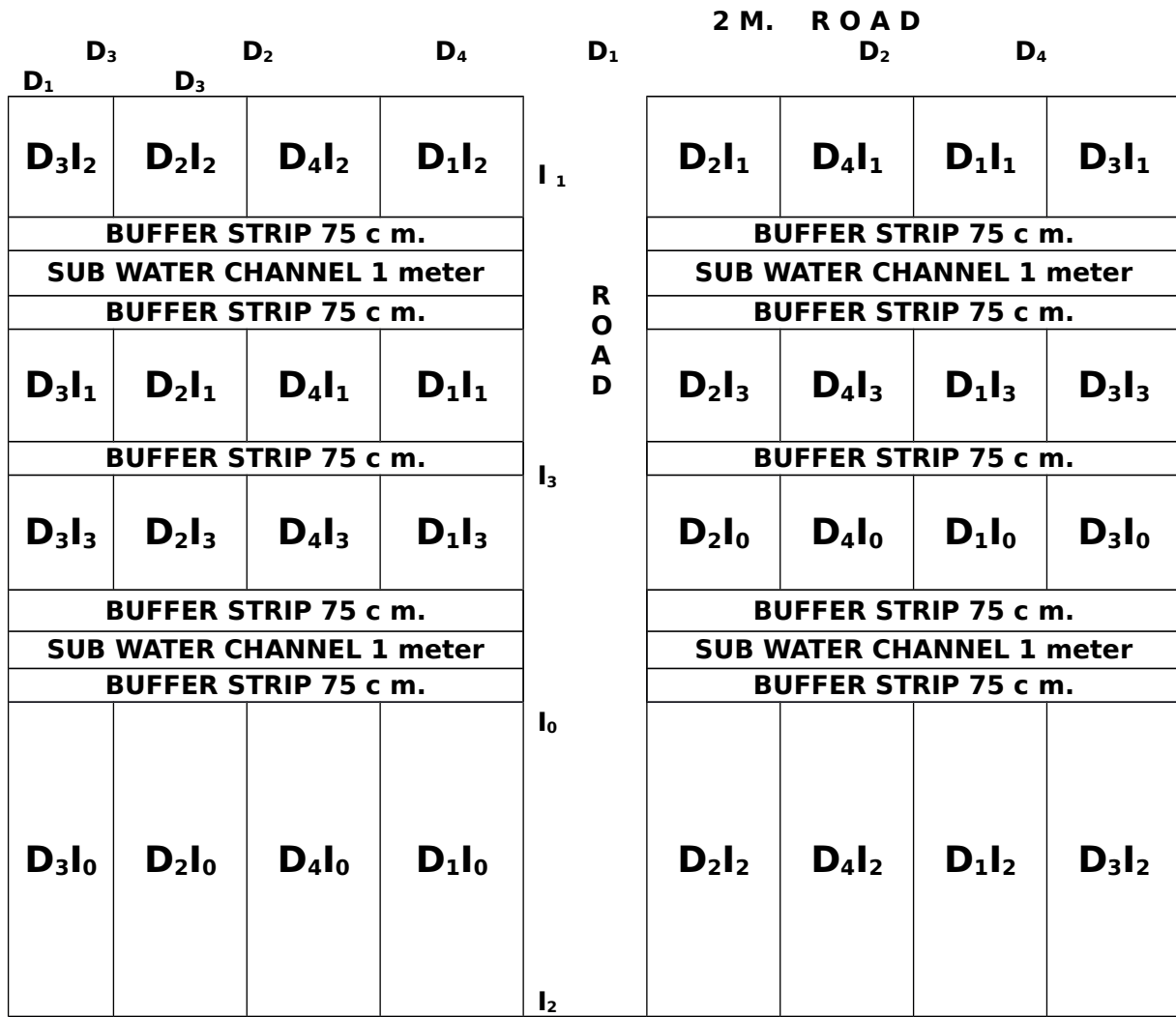
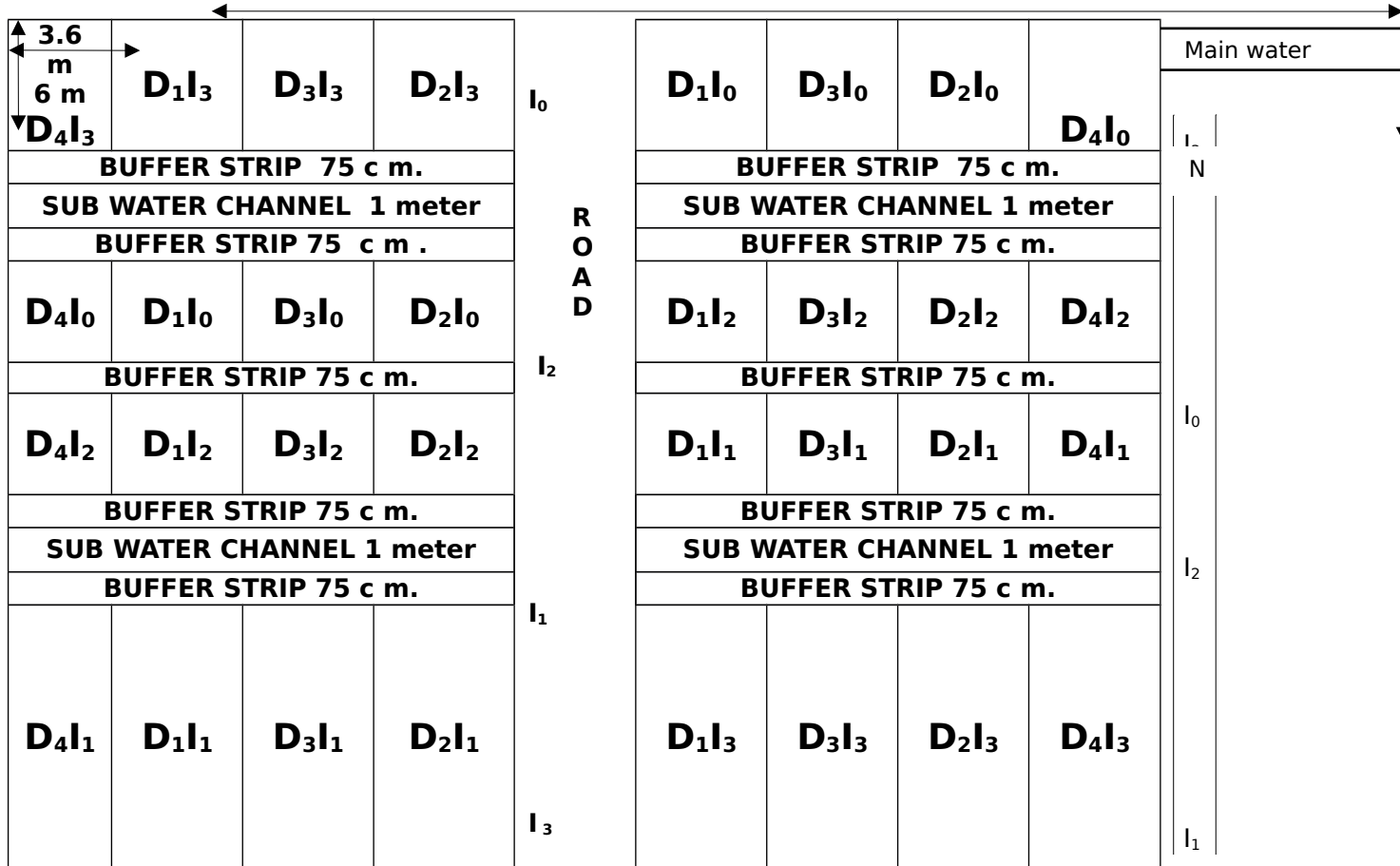
Fig. 4.9 Effect of date of sowing and irrigation scheduling (IW:CPE ratios) on consumptive use of water

Chart Title

- Temperature Max (0C)
- ◆ Temperature Min (0C)
- ▼ Sunshine hrs/day
- ▲ Evaporation (mm)
- ▶ Ave. Relative Humidity (%)



**Fig. 3.1 Meteorological data recorded during the course of investigation of the year 2010
(Weakly mean)**



61.5M

l_2

l_1

l_3

l_0

37

Fig. 3.2 layout plan of the experiment. Gross plot size 3.60 mx6.00 m, net plot size



Plate 1: Field view of experimental site.



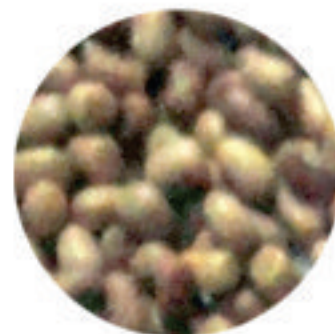
D_1
Sowing at 20th
January



D_2
Sowing at 30th
January



D_3
Sowing at 9th
February



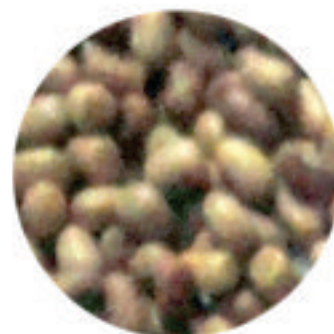
D_4
Sowing at 19th
February



I_0
Control
(Irrigation at critical growth stages)



I_1
0.5 IW : CPE
ratio



I_2
0.7 IW : CPE
ratio



I_3
0.9 IW : CPE
ratio

Plate 2 Seeds of summer moth bean under different date of sowing and irrigation scheduling based on IW:CPE ratios



D₁ Sowing at 20th January



D₂ Sowing at 30th January



D₃ Sowing at 9th February



D₄ Sowing at 19th February

Plate -3 Effect of different date of sowing



I_0 - (Irrigation at critical growth



0.5 IW:CPE ratio

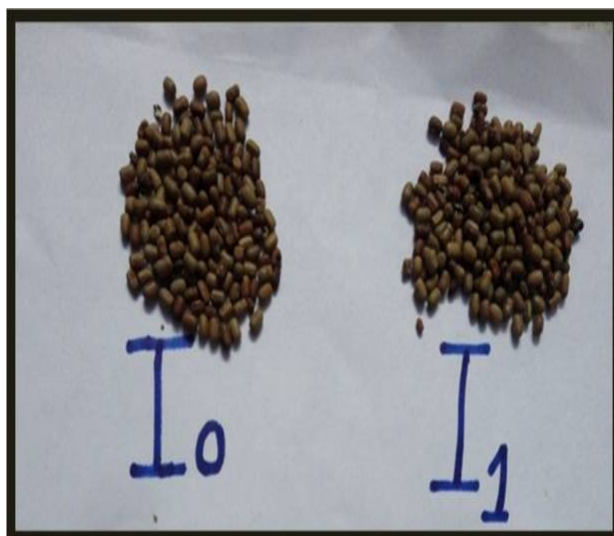


0.7 IW: CPE ratio



0.9 IW: CPE ratio

**Plate - 4 Effect of irrigation scheduling
(IW:CPE ratio)**



Control
(Irrigation at

0.5 IW:CPE
ratio



0.7 IW:CPE
ratio

0.9 IW:CPE
ratio



Sowing at 20th
January

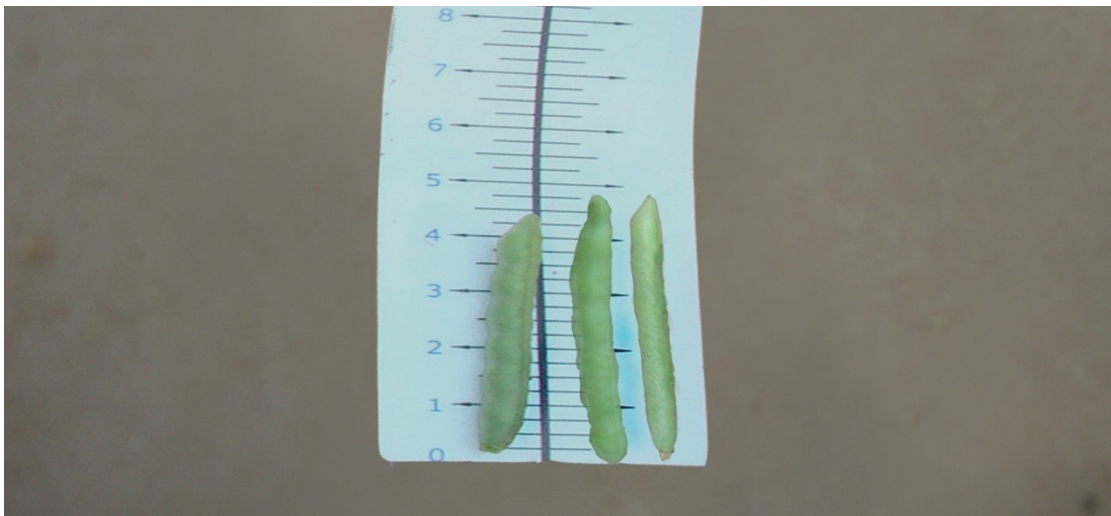
Sowing at 30th
January



D₃ Sowing at
9th February

D₃ Sowing
at 19th
February

Plate - 4. Seeds of summer moth bean under different date of sowing and irrigation scheduling based on IW:CPE ratios



Length of pods

Date	January					February					rse
	PE	CPE				PE	CPE				
		D ₁	D ₂	D ₃	D ₄		D ₁	D ₂	D ₃	D ₄	
1	-	-	-	-	-	3.7	47.5	11.3	-	-	
2	-	-	-	-	-	3.5	51	14.8	-	-	
3	-	-	-	-	-	3.8	54.8	18.6	-	-	
4	-	-	-	-	-	5.1	59.9	23.7	-	-	
5	-	-	-	-	-	4.0	63.9	27.7	-	-	
6	-	-	-	-	-	3.4	67.3	31.1	-	-	
7	-	-	-	-	-	3.1	70.4	34.2	-	-	
8	-	-	-	-	-	3.8	74.2	38.0	-	-	
9	-	-	-	-	-	4.2	78.4	42.2	4.2	-	
10	-	-	-	-	-	5.0	83.4	47.2	6.2	-	
11	-	-	-	-	-	4.8	88.2	52.0	14.0	-	
12	-	-	-	-	-	5.0	93.2	57.0	19.0	-	
13	-	-	-	-	-	5.5	98.7	62.5	24.5	-	
14	-	-	-	-	-	5.8	104.5	68.3	30.3	-	
15	-	-	-	-	-	5.1	109.6	73.4	35.4	-	
16	-	-	-	-	-	5.4	115.5	78.8	40.8	-	
17	-	-	-	-	-	5.2	120.2	84.0	46.0	-	
18	-	-	-	-	-	3.6	123.8	87.6	42.8	-	
19	-	-	-	-	-	5.7	129.5	93.3	48.5	5.7	
20	3.9	-	-	-	-	5.5	135	98.8	54.0	11.2	
21	3.5	7.4	-	-	-	5.3	140.3	104.1	59.3	16.5	
22	3.3	10.1	-	-	-	3.6	143.9	107.7	62.9	20.1	
23	3.7	14.4	-	-	-	5.3	149.2	113.0	68.2	25.4	
24	3.6	18	-	-	-	5.3	154.5	118.3	73.5	30.7	
25	4.1	22.1	-	-	-	4.9	159.4	123.2	78.4	35.6	
26	3.8	25.9	-	-	-	4.8	164.2	128.0	84.3	40.4	
27	4.0	29.9	-	-	-	5.9	170.1	133.9	90.2	46.3	
28	3.7	33.6	-	-	-	5.9	176	139.8	96.1	52.2	
29	2.6	36.2	-	-	-	-	-	-	-	-	
30	3.6	39.8	3.6	-	-	-	-	-	-	-	
31	4.0	43.8	7.6	-	-	-	-	-	-	-	

Date	March					25	April				
	PE	CPE					PE	CPE			
		D ₁	D ₂	D ₃	D ₄			D ₁	D ₂	D ₃	D ₄
1	6.1	182. 1	145. 9	102.2	58.3	8.2	407. 5	370.4	326. 6	282.8	
2	5.0	187. 1	150. 9	107.2	63.3	8.8	416. 3	379.2	335. 4	291.6	

Continue.....

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3	5.4	192. 5	156. 3	112.6	68.7	8.7	425. 0	387.9	344. 1	300
4	6.0	198. 5	162. 3	118.6	74.7	7.7	432. 7	395.6	351. 8	307.7
5	5.7	204. 9	168. 0	124.3	80.4	10.1	442. 8	405.7	361. 9	317.8
6	5.6	210. 5	173. 6	129.9	86.0	10.0	452. 8	415.7	371. 9	327.8
7	5.8	216. 3	179. 4	135.7	91.8	10.1	462. 9	425.8	382. 0	337.9
8	7.4	222. 7	186. 8	143.1	99.2	9.4	472. 3	435.2	391. 4	347.3
9	8.0	231. 7	194. 8	151.1	107. 2	5.8	478. 1	441.0	397. 2	353.1
10	9.1	240. 8	203. 9	160.2	116. 3	6.3	484. 4	447.3	403. 5	359.4
11	9.2	250	213. 1	169.4	125. 5	8.3	492. 7	455.6	411. 8	367.7
12	5.7	255. 7	218. 8	175.1	131. 2	10.1	502. 8	465.7	421. 9	377.8
13	8.3	264	227. 1	183.4	139. 5	10.2	513. 0	475.9	432. 1	388.0
14	8.6	272. 6	235. 7	192.0	148. 1	10.0	523. 0	485.9	442. 1	398.0
15	8.0	280. 6	243. 7	200.0	156. 1	10.0	533. 0	495.9	452. 1	408.0
16	6.4	287. 0	250. 1	206.4	162. 5	8.9	541. 9	504.8	461. 0	416.0
17	6.2	293. 1	256. 3	212.6	168. 7	9.5	551. 4	514.3	470. 5	426.4
18	6.4	299. 8	262. 7	219.0	175. 1	10.0	561. 4	524.3	480. 5	436.4
19	8.0	307. 8	270. 7	227.0	183. 1	8.9	570. 3	533.2	489. 4	445.3
20	8.0	315. 8	278. 7	235.0	191. 1	10.0	580. 3	543.2	499. 4	465.3
21	7.1	322. 9	285. 8	242.1	198. 2	8.3	588. 6	551.2	507. 7	473.6
22	8.1	331. 0	293. 9	250.2	206. 3	8.5	597. 1	559.7	516. 2	482.1
23	8.2	339. 2	302. 1	258.3	214. 5	8.9	606. 0	568.6	525. 1	491.0
24	7.4	346. 6	309. 5	265.7	227. 9	10.1	616. 1	578.7	535. 2	501.1
25	6.6	353. 2	316. 1	272.3	228. 5	12.4	628. 5	591.1	547. 6	513.5
26	7.2	360. 4	323. 3	279.5	235. 7	-	-	-	-	-
27	6.0	366.	329.	285.5	241.	-	-	-	-	-

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		4	3		7					
28	8.0	374. 4	337. 3	293.5	249. 7	-	-	-	-	-
29	8.0	382. 4	345. 3	301.5	257. 7	-	-	-	-	-
30	8.6	391	353. 9	310.1	266. 3	-	-	-	-	-
31	8.3	399. 3	362. 2	318.4	274. 6	-	-	-	-	-

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Table 3.7 Date of irrigation, number of irrigation and total quantity of irrigation water applied

Number of irrigation	D₁I₀ (Control-Irrigation at critical growth stages)	D₁I₁ (0.5 IW: CPE ratio)	D₁I₂ (0.7 IW: CPE ratio)	D₁I₃ (0.9W: CPE ratio)	D₂I₀ (Control -Irrigation at critical growth stages)	D₂I₁ (0.5 IW: CPE ratio)	D₂I₂ (0.7 IW: CPE ratio)	D₂I₃ (0.9W: CPE ratio)
Common	20/01/2010	20/01/2010	20/01/2010 0	20/01/2010 0	30/01/2010	30/01/2010	30/01/2010	30/01/2010
1	09/02/2010	13/02/2010 0	7/02/2010	03/02/2010 0	17/02/2010	20/02/2010 0	14/02/2010 0	12/02/2010 0
2	01/03/2010	04/03/2010 0	22/02/2010 0	15/02/2010 0	07/03/2010	10/03/2010 0	01/03/2010 0	23/02/2010 0
3	31/03/2010	18/03/2010 0	7/03/2010	26/02/2010 0	28/03/2010	23/03/2010 0	11/03/2010 0	05/03/2010 0
4	09/04/2010	31/03/2010 0	16/03/2010 0	08/03/2010 0	07/04/2010	05/04/2010 0	21/03/2010 0	13/03/2010 0
5		12/04/2010 0	24/03/2010 0	15/03/2010 0		13/04/2010 0	31/03/2010 0	20/03/2010 0
6		22/04/2010 0	1/04/2010	23/03/2010 0		26/04/2010 0	08/04/2010 0	28/03/2010 0
7			8/04/2010	29/03/2010 0			16/04/2010 0	03/04/2010 0
8			15/04/2010 0	05/04/2010 0			24/04/2010 0	09/04/2010 0
9				12/04/2010 0				16/04/2010 0
10				17/04/2010 0				22/04/2010 0
No. of	(1+4)=5	(1+6)=7	(1+8)=9	(1+10)=11	(4+1)=5	(1+6)=7	(1+8)=9	(1+10)=11

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irrigation Applied				1				1
Total quantity of irrigation water applied (mm)	250	350	450	550	250	350	450	550

continue

Number of irrigation	D₃l₀ (Control - Irrigation at critical growth stages)	D₃l₁ (0.5 IW: CPE ratio)	D₃l₂ (0.7 IW: CPE ratio)	D₃l₃ (0.9W: CPE ratio)	D₄l₀ (Control- Irrigation at critical growth stages)	D₄l₁ (0.5 IW: CPE ratio)	D₄l₂ (0.7 IW: CPE ratio)	D₄l₃ (0.9W: CPE ratio)
Common	09/02/2010	09/02/2010	09/02/2010	09/02/2010	19/02/2010	19/02/2010	19/02/2010	19/02/2010
1	02/03/2010	1/03/2010	23/02/2010	20/02/2010	05/03/2010	8/03/2010	4/03/2010	1/03/2010
2	16/03/2010	15/03/2010	8/03/2010	3/03/2010	18/03/2010	18/03/2010	23/03/2010	10/03/2010
3	05/04/2010	29/03/2010	17/03/2010	11/03/2010	29/03/2010	27/03/2010	1/04/2010	17/03/2010
4	16/04/2010	10/04/2010	27/3/2010	18/03/2010	08/04/2010	4/04/2010	7/04/2010	24/03/2010
5		20/04/2010	5/04/2010	26/03/2010		16/04/2010	13/04/2010	31/03/2010
6		30/04/2010	13/04/2010	02/04/2010		23/04/2010	19/04/2010	7/04/2010

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7			20/04/2010	8/04/2010			24/04/2010	13/04/2010
8			27/04/2010	14/04/2010			30/04/2010	19/04/2010
9				20/04/2010				24/04/2010
10				25/04/2010				30/04/2010
No. of irrigation Applied	(1+4)=5	(1+6)=7	(1+8)=9	(1+10)=11	(4+1)=5	(1+6)=7	(1+8)=9	(1+10)=11
Total quantity of irrigation water applied (mm)	250	350	450	550	250	350	450	550