RESPONSE OF DIRECT SEEDED AND TRANSPLANTED ONION (*Allium cepa* Linn.) TO DATES OF SOWING IN *KHARIF* SEASON UNDER NORTH GUJARAT CONDITION

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FEBRUARY – 2005

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ABSTRACT

RESPONSE OF DIRECT SEEDED AND TRANSPLANTED ONION (*Allium cepa* L.) TO DATES OF SOWING IN *KHARIF* SEASON UNDER NORTH GUJARAT CONDITION

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ABSTRACT

A field experiment was conducted during 2003-2004 at Agronomy Instructional Farm, C.P. College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar to study the "Response of direct seeded and transplanted onion (*Allium cepa* L.) to dates of sowing in *kharif* season under North Gujarat condition" on loamy sand soil.

Eight treatment combinations consisting of four dates of sowing *viz*., D_1 (18th August), D_2 (28th August), D_3 (7th September) and D_4 (17th September) as main plot treatments and two methods of sowing *viz*., S_1 (direct seeding) and S_2 (transplanting) as subplot treatments were tried in a factorial randomized block design with four replications.

The results indicated that almost all the growth and yield attributes were significantly influenced due to dates of sowing. Early sowing on 18th August (D_1) surpassed the later dates of sowing recording maximum values of plant height, number of leaves per plant, neck thickness, diameter of bulb, weight of bulb, bulb and straw yield, dry matter yield. Early sowing D_1 (18th August) also helped to minimize maturity period and reduced bolting and jointed bulb per cent over later dates of sowing. Dates of sowing did not influence the per cent total soluble solids of onion. Early sowing on 18th August (D_1) produced significantly the highest bulb yield of 303.3 q ha^{-1} followed by second date of sowing (28th August) with 290.3 q ha^{-1}. Delayed sowing D_4 (17th September) gave significantly the lowest yield of 240.6 q ha^{-1}. Treatment D_2 (28th August) produced the highest yield of A and B grade bulbs whereas D_1 (18th August) recorded the maximum yield of C grade bulbs. Maximum net realization of Rs. 90977 was obtained from early sowing on 18th August (D_1) whereas the lowest net realization of Rs.41715 was accrued from the last date of sowing *i.e.*, 17th September (D_4).

Between the methods of sowing, transplanting of seedlings (S_2) was found better than direct seeding (S_1), recording higher values of plant height, number of leaves per plant, neck thickness, diameter of bulb, weight of bulb, bulb and straw yield, dry matter per cent and dry matter yield. A grade and B grade bulb yield was also higher with the transplanting of seedlings (S_2). Transplanting of seedlings (S_2) also shortened the maturity period and decreased jointed bulb per cent over direct seeding (S_1). Methods of sowing did

not influence the bolting per cent and total soluble solids content of onion. Transplanting of seedlings (S_2) increased the bulb yield to the tune of 7.45 per cent over direct seeding (268.2 q ha^{-1}). Transplanting of seedlings (S_2) realized the additional net profit of Rs.21091 ha^{-1} over direct seeding of (S_1) onion.

Thus, the present study clearly indicated that transplanting of onion on 18th August gave maximum bulb yield and net realization over rest of the treatment combinations under North Gujarat condition.

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CERTIFICATE

This is to certify that the thesis entitled **"RESPONSE OF DIRECT SEEDED AND TRANSPLANTED ONION *(Allium cepa* Linn.) TO DATES OF SOWING IN *KHARIF* SEASON UNDER NORTH GUJARAT CONDITION"** submitted by **VAGHELA SHRAVANSINH JAMATSINH** in partial fulfilment of the requirements for the award of the degree of **"MASTER OF SCIENCE (AGRICULTURE)"** in the subject of **AGRONOMY** of the Sardarkrushinagar Dantiwada Agricultural University is a record of bonafide research work carried out by him under my guidance and supervision and thesis has not previously formed the basis for the award of my degree, diploma or other similar title.

Place : Sardarkrushinagar
Date : 25th February, 2005

(P. T. PATEL)
MAJOR ADVISOR

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Vaghela

Place: Sardarkrushinagar [VAGHELA S. J.]
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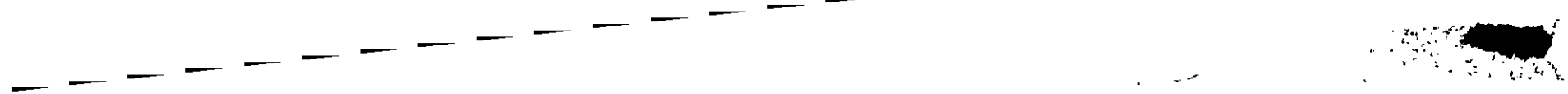

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CONTENT

ABBREVIATIONS USED

%	:	Per cent
@	:	At a rate of
°C	:	Degree Celsius
C.B.R.	:	Cost benefit ratio
C.D.	:	Critical Difference
C.V.	:	Co-efficient of variation
cm	:	Centimeter
cv.	:	Cultivar
DAS	:	Days after sowing
DATP	:	Days after transplanting
et al.,	:	et allii; and others
etc.	:	Et Citeras
Fig.	:	Figure
g	:	Gram
ha	:	Hectare
hr.	:	Hour
i.e.	:	That is
Kg	:	Kilogram
kg ha^{-1}	:	Kilogram per hectare
m	:	Meter
Max.	:	Maximum
Min.	:	Minimum
ml.	:	Milliliter
mm	:	Millimeter
N	:	Nitrogen
No.	:	Number
NS	:	Non significant
q ha^{-1}	:	Quintal per hectare
Rs.	:	Rupees
S.Em.	:	Standard Error of mean
viz.,	:	Videlicet (Namely)

INTRODUCTION

I. INTRODUCTION

Onion (*Allium cepa* L.) is one of the basic vegetables of mass consumption in India. It is the oldest vegetable crop in continuous cultivation dating back to atleast 4000 B.C. It is popularly used as both in green vegetable and mature bulb as well as spices. It can be stored for a longer period without deterioration in the quality. Among the vegetable crops grown in the country it assumes significance in the national economy by occupying fifth position next to root crops. It is popular salad crop and consumed as different preparations, like cooked vegetable in soups,curies, fried, stews and casseroles and in pickles and for other purposes. Onion is dehydrated and powedered for general use and for flavouring the edible products. Because of its importance in cookery, onion is called "Queen of the Kitchen" by the Germans. It is one of the few versatile vegetable crops that can safely withstand the hazards of rough handling including long distance transportation.

Onion also posseses nutritional and medicinal importance. It contains vitamin-B and traces of vitamin C, iron and calcium. Its pungency is due to volatile oil known as "Allyl propyl disulphide," which acts as a gastric stimulant and promotes digestion (Yawalkar, 1969). It is used as a remedy for various diseases like dysentery, infantile, convulsions, headache, hysterial fits, rheumatic pain, malarial fever and as a fine demulcent to give relief in piles (Nadkarni,1927). It contains 87.5 per cent water and provides energy to the extent of 49 calories, 1.4 g proteins, 32 g calcium, 20 I.U. vitamin A, 0.12 mg

riboflavin, 0.1 mg niacin, 1.2 mg albuminoides and 0.4 mg ash per 100 g of fresh edible portion.

Onion is a member of "Alliaceae" family. The other members of this family are asparagus, garlic, leek *etc.* The Allium genus comprises of 300 to 500 species, which are widely distributed in the northern temperate region. The common onion grown for dry bulb is *Allium cepa* Linn. (Thomson and Kelly, 1957) and centre of origin is believed to be Afghanistan and the surrounding region. Onion is biennial in the sense that it takes one season to develop bulbs from seeds and another season for seed production from bulbs. Onion has now become one of the important crops of Saurashtra region of Gujarat state. Area under this crop is increasing due to its year round demand in the market and comparatively high price. Increasing demand of onion obviates the necessity for increasing its production.

According to All India estimates of 1999-2000, onion covered an area of 0.49 million hectares with total production of 4.89 million tones (Anon., 2000) and accounts for about 93 per cent of the total export of vegetables (Singh *et al.,* 1976). Maharashtra, Gujarat, Karnataka, Tamil Nadu, Madhya Pradesh, Uttar Pradesh, Andhra Pradesh and Bihar are the major onion growing states in India. In the world, India is prominent in production and export of onion. India's share in the world's production is about 8 per cent (Shukla, 1983). India ranks first in area and second in production next to China. In Gujarat, onion occupied an area of about 52,200 hectares with total bulb production of about 14,62,100 metric tones during 1998-99 (Anon., 1999). The major onion

growing districts in Gujarat are Bhavnagar, Amreli, Junagadh, Rajkot, Mehsana, Jamnagar, Surat and Anand.

Onion is an important *rabi* crop of the Saurashtra region of Gujarat. Out of the total production in India, 30 per cent accounts for *kharif* and the late *kharif* season and 70 per cent to *rabi* season. Due to favourable climatic conditions, it is grown in Maharashtra, especially in Nasik district in *kharif* as "Pol" and in late *kharif* as "Rangada" in addition to *rabi* crop as "Unal." Onion cultivation in *kharif* is also initiated in Gujarat to catch off-season market.

Cool and dry weather condition suits to onion crop but it can also be grown over a wide range of temperatures. The plant grows best between 12.77°C and 23.88°C. Optimum growth and development occurs when temperature is low during early development and then warm up near maturity when bulbing is taking place. Above 29.44°C and below 7.22°C growth of onion crop is influenced. The plant is fairly resistant to frost injury but below 2°C some damage may occur.

Bulb development is greatly affected by climatic conditions, chiefly day length and temperature. Thus expose to day length lesser than that necessary for bulbing, cause high percentage of non-bulbous plants. Conversely, if a cultivar is exposed to day lengths longer than that required for bulbing, premature bulbing is induced in small plants, resulting in reduced bulb size and low yield. Thus proper time of sowing plays an important role in cultivation of onion. Initiation of onion cultivation in *kharif* to catch early market has led to advocate the farmers for proper time of sowing especially in North Gujarat.

Raising of onion by transplanting of seedlings is labour intensive. the increasing labour cost year after year and unavailability of labours at the time of transplanting is affecting cultivation of onion. The alternative is direct seeding, however its suitability and comparative economics for cultivation of onion during *kharif* need to be investigated. Keeping this in view. an experiment entitled "Response of direct seeded and transplanted onion (*Allium cepa L.*) to dates of sowing in *kharif* season under North Gujarat condition" was conducted during 2003-04 at Agronomy Instructional farm, C. P. College of Agriculture, Sardarkrushinagar,. with the following objectives.

OBJECTIVES :

[1] To find out the effect of different dates of sowing on growth, yield and quality of onion.

[2] To study the effect of methods of sowing on growth, yield and quality of onion.

[3] To study the interaction effect of dates and methods of sowing on growth, yield attributes and yield of onion.

[4] To workout the economics of different treatments.

REVIEW OF LITERATURE

II. REVIEW OF LITERATURE

The main aim of agricultural research is to increase the crop yield per unit area per unit time by prudent use of available inputs without deteriorating the soil health.

Time of sowing, a non-monetary input, plays a significant role in production of onion. Temperature is one of the most important factors to decide optimum time of sowing.

The importance of sowing method for realizing potential yield from any crop is well recognized. It is well known that optimum plant spacing avoids undue competition for moisture, nutrients and light, which ultimately results into higher crop yield. This is also partly due to enhanced rate of photosynthesis.

Very merge information is available regarding the time and method of sowing for *kharif* onion crop. This is particularly true with regard to study under different agro-climatic conditions of Gujarat. Here an attempt is made to present the recent work carried out in India and abroad related to the problem under study. This has been highlighted and reviewed under the following broad topics.

2.1 EFFECT OF DATES OF SOWING

2.2 EFFECT OF METHODS OF SOWING

2.1 EFFECT OF DATES OF SOWING :

Among various agro-techniques, date of sowing is the most important non-monetary input influencing growth, yield attributes and yield of onion. The work so far has been carried out to identify appropriate sowing/transplanting period of onion to obtain maximum production, is reviewed as under.

Kakehi (1958) studied planting of Kodaka onion at Hiroshima Agricultural College during spring season and reported that the yield increased with planting dates in ascending order of February 5th, March 1st, March 25th and April 17th.

Arora (1967) conducted an experiment at I.A.R.I., New Delhi during 1963-64 and 1964-65 on transplanting of seedlings at different dates *viz.*, 1st, 11th, 21st, 31st January, 10th and 20th February in first year and 22nd December, 1st, 11th, 31st January, 10th, 20th February in second year. Gradual decrease in weight of bulb and the yield of onion was observed when the transplanting delayed after 22ndDecember.

Verma *et al.* (1971) reported the effect of dates of sowing on the performance of onion crop by sowing seeds on 1st, 8th, 15th or 22nd October and transplanting the seedlings when they attained 4, 6, 8, and 10 weeks age. It was observed that the earliest sowing date (1st October) proved to be the best in terms of growth and yield.

Singh *et al.* (1971) studied the effect of dates and methods of planting on yield of onion on clay loam soil at J.N.K.V.V., Rewa (Madhya Pradesh).

Transplanting of seedlings on 28th December gave higher yield over planting on 12th and 27th January. Early planting significantly affected the diameter of bulb and also the yield. The increase in yield was due to early transplanting.

From the results of an experiment conducted at Pantnagar during 1964–65, Singh and Singh (1974) determined the suitable sowing time for transplanting of onion (Pusa Red). They observed maximum growth of leaf and root as well as bulb yield when sown on October 16th but the growth progressively decreased with further delay in sowing. Similarly, from the trials conducted at Ranikhet (Uttar Pradesh). Joshi *et al.* (1975) concluded that the highest yield of onion per ha could be obtained with transplanting of seedlings on November 15th. The yield declined significantly with delay in transplanting time *i.e.*, on December 15th and January 15th.

Moursi *et al.* (1975) reported the findings of two trials on onion cv. Giza conducted at Ain shams University, Cairo (Egypt) comprising four sowing dates (between mid August and first October) and six seed rates (5 to 17.5 kg/feddan). Delayed sowing (after August) resulted in reduction in plant height and number of tubular leaves.

Allen *et al.* (1978) studied the effect of dates of planting on yield of over wintered onions at University college of Wales, Aberystwyth, U.K. for three years. They showed that delay in sowing from mid August to late September increased plant losses during winter and decreased yields of ware-size onions.

Sharma and Arora (1983) conducted a field trial in *kharif* season of 1982 at I.A.R.I., New Delhi on the calcareous sandy loam soil to find out the effect

of dates of transplanting (16th August, 2nd and 17th September. 4th and 20th October). Significantly higher yield was observed when the crop was transplanted on 16th August.

Nagre *et al.* (1985) studied the effect of dates of sowing on bolting and splitting of bulb at P.K.V., Akola during *rabi* season. They observed more bolting in mid-December planting followed by mid-January planting whereas the mid-February planted crop was found free from bolting. Bulb splitting percentage was the highest in December planting and the lowest in February planting.

Lawade and Kale (1986) found out the effect of dates of sowing on bolting and twin bulb formation conducting an experiment at Pune during 1981-82 and 1982-83. They noticed maximum percentage of premature bolting in August and September sowing.

Bhamburkar *et al.* (1986) investigated the effect of dates of transplanting on bolting, conducting an experiment at P.K.V., Akola during 1983-84. Lower bolting was found with January planting over that of December or February.

Vanparijs (1988) found out the effect of sowing dates and spacing on cv. Avanti at Belgium. He found that the highest yield was recorded from the early sowing date (12th to 17th August).

Tomar *et al.* (1988) carried out an experiment at College of Agriculture, J.N.K.V.V., Gwalior in winter season during 1979-80 and 1980-81 on a sandy loam soil to find out the effect of different dates of planting (15th Nov.,

15th Dec. and 15th Jan.) on yield of onion. Early planting on 15th November significantly increased size and weight of bulbs than late planting.

Bhonde *et al.* (1990) studied the effect of dates of sowing on different parameters like doubles, bolting and total soluble solids. Dates of sowing did not exert significant influence on doubles, bolting and total soluble solids. However, maximum bolting was observed in 30th August planting, might be due to cold spell in December at the time of harvest.

Pandey *et al.* (1990) conducted an experiment at Regional Research Station, A.A.D.F., Karnal (Salaro), Haryana during 1982-83 to 1984-85 on Pusa Red variety to study the response of dates of transplanting (15th Dec., 1st and 16th Jan.) on yield of onion. Significantly higher gross yield and diameter of bulb was recorded with 15th December planting remaining at par with 1st January planting. Total soluble solids content was not affected due to dates of sowing.

Richwine (1990) reported the results of the experiment conducted at Vegetable Research Station, Texas, A and M University, Munday, U.S.A. during 1985-86 on cv. sweet winter to study the effect of sowing dates on yield of onion. Transplanting on 19th or 27th September recorded the highest yield of onion.

Mohanty *et al.* (1990) studied the effect of time of transplanting in onion and found that November 20th planting gave the highest weight per bulb, which gradually decreased with successive date *i.e.*, January 19th.

Singh and Korla (1991) conducted an experiment during 1987-88 and 1988-89 to study the effect of transplanting dates (at fortnightly intervals starting from November 16th to December 31st) and varieties (Pusa Red and Nasik Red) on number of leaves in onion. They found that later transplanting (December 31st) resulted decrease in number of leaves and bulb yield.

Mulkey and Talbot (1992) conducted an experiment to investigate the effect of planting dates on onion. They found that highest total marketable yield was obtained when crop was sown on 3rd October compared to 10th October.

Pandey and Tripathi (1992) conducted an experiment at Bangalore on sandy loam soil using the seeds of small onion cv. Bangalore Rose during *kharif* season by broadcasting on 1st June, 15th June, 30th June, 15th July and 30th July. The highest yield was obtained with the 1st July sowing (209.25 q ha^{-1}) as compared to other sowing dates.

Bharmburkar *et al.* (1993) reported the results of the experiment conducted at P.K.V., Akola during 1983-84. They noted significant increase in growth, bulb size and weight in December planted crop. Successive delay in planting (January and February) resulted reduction in these parameters. They also observed that December planting gave the highest yield of 513.89 q ha^{-1}.

Singh *et al.* (1993) conducted an experiment at Narendra Deva University of Agricultural technology, Narendranagar, Faizabad during *rabi* season of 1990-91 and 1991-92 on cv. 'Pusa Red' with 15th days interval of transplanting initiating from December 26th to January 25th. It was concluded

that maximum height of plant, number of leaves per plant, bulb diameter and yield (q ha^{-1}) were registered with planting on 26th December. The bolting percentage was zero when seedlings were planted on January 25th during both the years.

Singh (1993) carried out an experiment at Central Arid Zone Research Institute, Regional Research Station, Pali in *rabi* season of 1991-92 wherein seedlings were transplanted on November 15th and 25th; December 5th, 15th and 25th and January 5th. The size and average weight of bulb were higher in November transplanted crop than the later dates of transplanting.

Madisa (1994) conducted an experiment at Department of Agricultural Research, Bangkok, Thailand during 1993 wherein seedlings were planted in mid February, mid March and mid April. The planting done in mid March resulted in higher yield over that of in mid February or mid April.

An experiment was conducted on sandy loam soil of Mymensingh, Bangladesh during 1991-92 to find out optimum planting date of onion cv. Tuherpuri. Planting on 20th December recorded the highest yield of onion (Amin *et al.*, 1995).

Kavani (1996) conducted an experiment at Gujarat Agricultural University, Junagadh during *rabi* season of 1994-95 on cv. Junagadh local on medium black soil. Significant increase in plant height and number of leaves per plant was observed with sowing on 15th October while delayed sowing (30th October and 15th November) resulted decease in plant height and number

in leaves per plant. Highest diameter of bulb and maximum yield was also recorded with 15th October planting.

Movalia (1996) conducted an experiment at Gujarat Agricultural University, Junagadh to find out the effect of dates of sowing on yield of onion cv. Agri-found Dark Red during *kharif* 1995-96. The highest plant height, number of leaves per plant, diameter of bulb and yield (320.51 q·ha^{-1}) was recorded with sowing on 10th August, but decreased with delay in sowing on 25th August and 9th September.

Gupta *et al.* (1999) conducted an experiment at H.A.U., Hissar during 1994-96 on cv. Agrifound Dark Red to study the effect four dates (25th December, 15th January; 5th and 25th February) of sowing on yield of onion. They found that the highest yield of large size sets (> 1.75 cm diameter) was recorded from 25th February.

Hiray (2001) carried out an experiment on medium black soil at Gujarat Agricultural University, Paria, during *rabi* season of 1999 to find out the effect of dates of planting (15th November, December 7th and 30th) on growth and yield of onion. Higher plant height, number of leaves per plant, neck thickness, diameter of bulb and bulb yield (329.97 q ha^{-1}) was obtained with planting on 15th November as compared to planting on 7th and 30th December

Cheema *et al.* (2003) investigated the effect of sowing dates on set size of onion at Vegetable Research Institute, Faizabad, Pakistan during 2000-2001 and 2001-2002. The crop was sown in 1st or 3rd week of November 1st or 3rd week of December 2nd and 4th week of January 3rd week of February and

1st week of March. It was observed that sowing in 3rd week of December 2nd and 4th week of January resulted in desirable set size, whereas sowing in the 1st week of March gave the highest average number of sets/kg.

Rajeshkumar *et al.* (2003) conducted an experiment on dates of sowing on onion at CCS Haryana Agricultural University, Hissar, during 2000-2001. Seeds were sown at an interval of 10th days beginning from 1st December to 10th February. Sowing on 1st and 11th December produced significantly higher plant height, diameter of bulb and bulb yield as compared to later sowing dates.

2.2 EFFECT OF METHODS OF SOWING :

Khokhar *et al.* (1990) conducted an experiment in Pakistan during the autumn and spring season of 1985-86 in order to select high yielding onion cultivars. Direct seeding and transplanting were compared to determine the appropriate method of sowing. The transplanting method improved bulb weight (80.50 to 441.50 g) and bulb yield (5.20 to 31.40 t ha^{-1}) as compared to direct seeding giving lower bulb weight (20.75 to 177.75 g) and bulb yield (6.43 to 26.75 t ha^{-1}).

Warid and Loaiza (1993) conducted an experiment on short day onion cultivars (four white, two red and seven yellow brown locally preferred by consumers in that order) sown direct on 18th September or transplanted on 28th November (from sowing on 18th September) and harvested on 28th April in the following year. Transplanting method yielded (44.1 t ha^{-1}) better than direct sowing (36.2 t ha^{-1}).

Kapadia (1996) studied the performance of methods of sowing at Agronomy Instructional Farm, Gujarat Agricultural University, Junagadh during 1994-1995 on onion Junagadh local. He indicated that transplantation of seedlings gave significantly higher plant height, number of leaves per plant, diameter of bulb and bulb yield (374.99 q ha^{-1}) as compared to direct seeding.

Movalia (1996) investigated the response of onion to methods of sowing in late *kharif*/semi *rabi* season of 1995-96 at Agronomy Instructional Farm, Gujarat Agricultural University, Junagadh. He found significant increase in plant height, number of leaves per plant, diameter of bulb and yield with transplanting method as compared to direct seeding.

Massiha *et al.* (2001) investigated the effect of methods of sowing on onion at Khalat–Pooshan Research Station, Tabriz University in Iraq during 1999. They showed that transplanting method had higher values of total yield, marketable yield, percentage of class I and III, bulb weight, bulb diameter and neck thickness than other methods.

Sukhadia *et al.* (2002) conducted an experiment on rainy season onion during 1997, 1999 and 2000 on vertisols at Gujarat Agricultural University, Junagadh to evaluate methods of sowing and weed management practices. They concluded that transplanting method recorded significantly higher bulb girth, bulb yield and net return than broad casting of seeds.

Interaction effect of dates and methods of sowing :

Khokhar *et al.* (1990) reported the results of an experiment conducted in Pakistan during 1985-86 to find out the effect of sowing time and method on yield of onion. They indicated that the third week of December is optimum for transplanting for getting maximum weight and yield of mature bulbs.

MATERIALS AND METHODS

III. MATERIALS AND METHODS

The details of materials used and methods adopted in conducting the present experiment are described in this chapter under following heads.

3.1 EXPERIMENTAL SITE :

The present investigation entitled "Response of direct seeded and transplanted onion (*Allium cepa L.*) to dates of sowing in *kharif* season under North Gujarat condition" was carried out during 2003-2004 at the Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture (erstwhile Gujarat Agricultural University), Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar.

3.2 CLIMATE AND WEATHER CONDITIONS :

Geographically, Sardarkrushinagar is located on 24° –19' North latitude and 72° – 19' East longitude with an elevation of 154.52 meters above the mean sea level. The climate of this region is typical sub-tropical monsoon type and falls under semi-arid region. It represents the North Gujarat Agro-climatic zone of Gujarat state.

Generally, the monsoon is warm and moderately humid, commences in third week of June and retreats by the middle of September. Most of the precipitation is received from southwest monsoon, concentrating in the months of July and August. The annual average rainfall is about 550 mm with 22 rainy days (average of last 22 years).

The winter is fairly cold and dry in the months of November and continues till the middle of February. December and January are the coldest

months of winter. Summer season commences in the second fortnight of February and ends in the middle of June. May and June are the hottest months of summer.

The standard weekwise meteorological data on maximum and minimum temperature, relative humidity, bright sunshine hours and rainfall recorded during the period of this investigation at the meteorological observatory, Agronomy Instructional Farm, C. P. College of Agriculture, Sardarkrushinagar are presented in Table 1 and graphically depicted in Fig.1.

3.3 PHYSICO-CHEMICAL PROPERTIES OF THE EXPERIMENTAL PLOT :

The experimental field had an even topography with a gentle slope and good drainage. The soil samples were taken randomly from different spots in the field before commencement of the experiment at the depth of 0-15 cm and 15-30 cm and a composite sample was prepared and analyzed for physical and chemical properties of the soil. The values of soil analysis along with methods followed are furnished in Table 2.

The soil analysis indicated that the soil of the experimental plot was loamy sand in texture and slightly alkaline in reaction. It was low in organic carbon and available nitrogen, while medium in available phosphorus and potash.

Table 1 : Standard week-wise meteorological data

Month and year	Std. week	Dates	Temperature (°C)		Relative humidity (%)		Bright Sunshine hrs./day	Rainfall (mm.
			Max.	Min.	7.40	14.40		
Aug.-2003	32	06-12	32.6	26.2	94.6	66.7	4.7	31 2
	33	13-19	33.2	25.6	89.0	54.4	5.7	0.0
	34	20-26	32.8	25.6	91.4	69.3	3.2	58 8
	35	27-02	29.4	24.9	95.6	76.4	1.3	25 0
Sept.-2003	36	03-09	31.9	23.9	92.3	61.3	3.2	0 0
	37	10-16	32.4	24.2	89.6	54.9	5.7	0.0
	38	17-23	33.1	24.5	93.3	61.3	5.5	93 8
	39	24-30	34.2	24.9	89.7	51.6	8.3	10.3
Oct.-2003	40	01-07	31.9	20.8	83.3	24.9	9.3	0 0
	41	08-14	36.3	19.3	84.0	26.1	9.7	0 0
	42	15-21	36.5	17.5	74.1	19.1	9.9	0 0
	43	22-28	35.9	14.5	76.1	16.4	10.2	0 0
	44	29-04	35.3	16.6	71.3	26.1	9.8	0 0
Nov.-2003	45	05-11	35.1	16.6	87.3	28.6	9.3	0 0
	46	12-18	32.6	14.9	70.8	27.9	9.4	0 0
	47	19-25	30.1	14.4	66.0	23.3	8.3	0 0
	48	26-02	31.4	11.2	83.1	22.6	9.0	0 0
Dec.-2003	49	03-09	31.2	12.5	77.9	21.4	9.0	0.0
	50	10-16	28.9	12.4	77.1	28.3	8.5	0 0
	51	17-23	26.5	10.1	75.4	23.7	8.6	0.0
	52	24-31	25.6	7.4	75.1	25.4	8.8	0 0
Jan.-2004	1	01-07	26.7	9.2	76.4	33.4	7.8	0.0
	2	08-14	28.2	9.0	86.1	25.7	8.0	0.0
	3	15-21	28.7	10.9	81.9	35.9	6.9	0.0
	4	22-28	25.0	7.7	81.3	23.7	9.3	0.0
	5	29-04	26.1	8.9	71.4	19.1	9.8	0.0
Feb.-2004	6	05-11	28.3	8.1	73.6	19.9	10.2	0.0
	7	12-18	31.3	11.4	79.4	21.4	9.9	0.0
	8	19-25	32.7	12.8	82.6	18.3	9.7	0.0
	9	26-04	34.4	14.8	67.8	11.0	10.1	0.0
Mar.-2004	10	05-11	37.3	14.1	60.1	13.1	9.3	0.0
	11	12-18	39.3	17.6	61.9	13.1	10.3	0.0
	12	19-25	39.6	19.0	69.9	16.3	10.2	0.0
	13	26-01	37.0	16.2	66.9	16.6	10.0	0.0
Apr.-2004	14	02-08	37.2	21.3	78.3	26.6	8.0	0.0
	15	09-15	38.6	22.9	73.3	25.3	10.0	0.0
	16	16-22	37.9	22.3	69.3	29.1	10.1	0.0
	17	23-29	40.1	23.4	68.3	18.3	10.0	0.0
	18	30-06	40.3	23.3	47.1	16.6	8.0	0.0

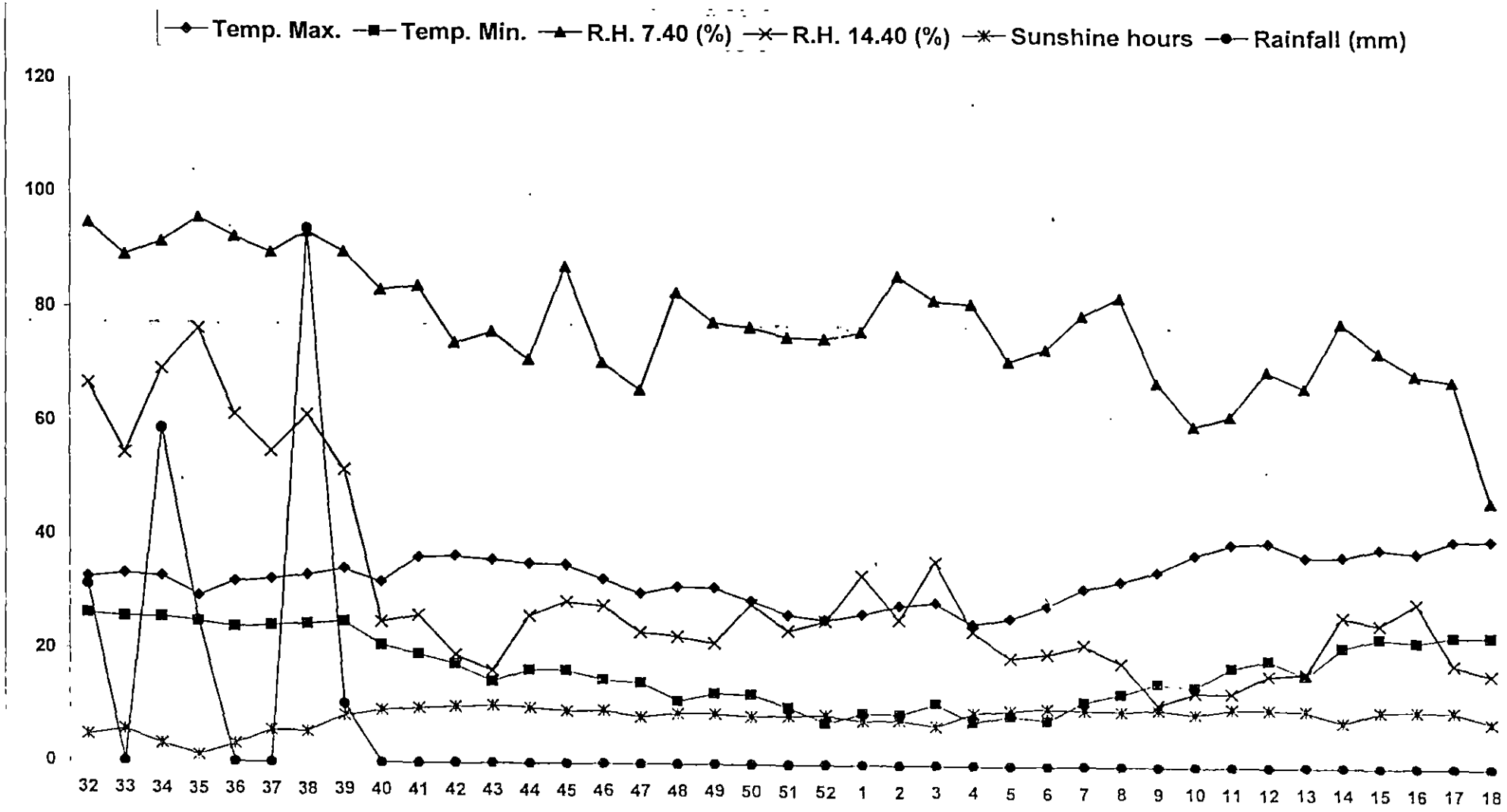


Fig. 1 : Standard week-wise meteorological data

Table 2 : Physico-chemical properties of experimental plot

Sr. No.	Particulars	Soil depth (cm) 0-15	Soil depth (cm) 15-30	Method employed
(A)	**MECHANICAL COMPOSITION :**			
1.	Sand (%)	83.92	84.51	International Pipette Method (Piper, 1950
2.	Silt (%)	6.78	6.90	
3.	Clay (%)	7.88	7.92	
4.	Texture class	Loamy sand		
(B)	**CHEMICAL PROPERTIES :**			
1.	pH (1:2.5 soil : water ratio)	7.60	7.8	Buckman's glass electrode pH meter (Jackson, 1967)
2.	Electrical Conductivity (dSm^{-1})at 25°C (1:2.5 soil: water ratio)	0.17	0.16	Electrical conductivity meter (Jackson, 1967)
3.	Organic carbon (%)	0.19	0.17	Walkley and Black rapid titration Method (Jackson, 1967).
4.	Available N ($Kg\ ha^{-1}$)	168.30	163.20	Alkaline Permanganate Method (Jackson, 1967)
5.	Available P_2O_5 ($Kg\ ha^{-1}$)	49.35	51.20	Olsen's Method (Jackson, 1967)
6.	Avaible K_2O ($Kg\ ha^{-1}$)	271.49	265.90	Flame Photometer Method (Jackson, 1967)

3.4 CROPPING HISTORY OF THE EXPERIMENTAL PLOT :

The cropping history in respect of the crops taken and fertilizers applied to the experimental plot during the three years preceding the present investigation is summarized in Table 3.

3.5 EXPERIMENTAL DETAILS :

The details of the experiment are given as under :

3.5.1 Title

Response of direct seeded and transplanted onion (*Allium cepa L.*) to dates of sowing in *kharif* season under North Gujarat condition.

3.5.2 Design of experiment

Total eight treatment combinations comprising of four dates of sowing and two methods of sowing were tested in a factorial randomized block design with four replications.

Details of treatments :

Dates of sowing :

D_1 = 18th August

D_2 = 28th August

D_3 = 7th September

D_4 = 17th September

Methods of sowing :

S_1 = Direct seeding (Broadcasting of seeds)

S_2 = Transplanting of seedlings (40 days old)

Table 3 : Cropping history of experimental plot

Year	Season	Crop	Fertilizers (Kg ha^{-1}) applied		
			N	P_2O_5	K_2O
2001-2002	*Kharif*	Green gram	20	40	0
	Rabi	Wheat	120	60	0
	Summer	Fallow	-	-	-
2002-2003	*Kharif*	Cluster bean	20	40	0
	Rabi	Wheat	120	60	0
	Summer	Fallow	-	-	-
2003-2004	*Kharif*	Onion present investigation	100	50	50

Treatment combinations :

Treatment number	Treatment combination	Date of sowing	Method of sowing
1	D_1S_1	18th August	Direct seeding
2	D_1S_2	18th August	Transplanting
3	D_2S_1	28th August	Direct seeding
4	D_2S_2	28th August	Transplanting
5	D_3S_1	7th September	Direct seeding
6	D_3S_2	7th September	Transplanting
7	D_4S_1	17th September	Direct seeding
8	D_4S_2	17th September	Transplanting

3.5.2 Details of layout

The experiment was laid out in a factorial randomized block design as per layout shown in Fig. 2.

Crop : Onion

Variety : Agri-found Dark Red

Number of replications : 4

Total number of treatment combinations : 8

Total number of plots : 32

Plot size — Gross : 3.0 m × 1.5 m

Net : 2.4 m × 1.2 m

Spacing — Direct seeding : Broadcasting

Transplanting : 15 cm ×10 cm

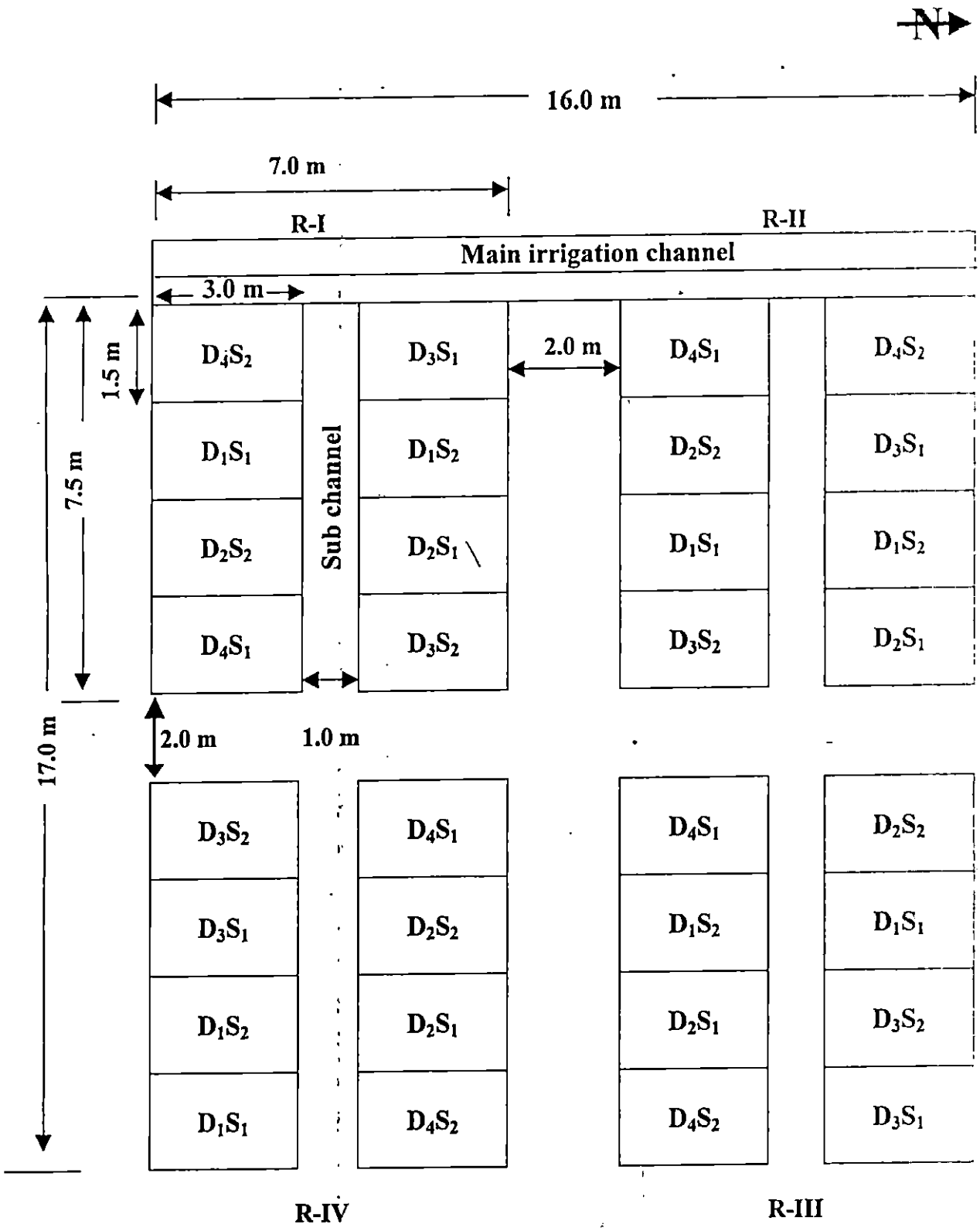


Fig. 2 : Lay out of the experiment

Plate I General view of experimental plot

Total number of rows in transplanting	(a)	Gross : 10
	(b)	Net : 8
Seed rate	:	10 kg ha^{-1} for direct seeding

3.6 CHOICE OF ONION CULTIVAR :

The onion cultivar Agri-found Dark Red was used as a test crop in the present study. Agri-found Dark Red cultivar developed by Associated Agricultural Development Foundation (AADF) has been released by Government of India for cultivation in all the *kharif* onion growing areas of the country (Bhonde *et al.*, 1991).

3.7 CULTURAL OPERATIONS :

The schedule of various cultural operations carried out in the experimental field during crop season is presented in Table 4.

3.7.1 Preparatory cultivation

The fallow field was cultivated in both the directions by tractor drawn cultivator and the residues of weeds were collected and finally planking was done. Then, the field was laid out as per plan of the layout (Fig. 2) and beds were prepared.

The sequence of field operations carried out during investigation period is given in Table 4.

3.7.2 Raising of seedlings

Raised beds of 3.0 m × 1.0 m with 15 cm height were prepared separately for raising the seedlings in the month of August and September 2003. Ten-kilograms well rotten farmyard manure and 0.1 kg Diammonium

Table 4 : Calendar of cultural operations carried out during the course of investigation

Sr. No	Field operations	Dates of operation			
		D_1	D_2	D_3	D_4
[A]	**PRE-SOWING/TRANSPLANTING OPERATIONS :**				
I.	**Nursery Management :**				
1.	Tractor cultivation and planking	15/8/03	15/8/03	15/9/03	15/9/03
2.	Raised bed preparation	18/8/03	28/8/03	7/9/03	17/9/03
3.	Nursery sowing	18/8/03	28/8/03	7/9/03	17/9/03
4.	Application of fertilizers	18/8/03	28/8/03	7/9/03	17/9/03
5.	Hand weeding	7/9/03	18/9/03	29/9/03	11/10/03
6.	Irrigation	As and when required			
II.	**Field operations :**				
7.	Cultivation with tractor	15/8/03	15/8/03	15/8/03	15/8/03
8.	Removal of stubbles	16/8/03	16/8/03	16/8/03	16/8/03
9.	Planking with bullock	16/8/03	16/8/03	16/8/03	16/8/03
10.	Field layout, opening of furrows and channels	17/8/03	17/8/03	17/8/03	17/8/03
11.	**Application of fertilizers Full dose of P_2O and K_2O**				
	(a) Direct seeding	18/8/03	28/8/03	7/9/03	17/9/03
	(b) Transplanting of seedlings	27/9/03	7/10/03	17/10/03	27/10/03
[B]	**SOWING/TRANSPLANTING :**				
12.	(a) Direct seeding of onion seeds in plot (broadcasting)	18/8/03	28/8/03	7/9/03	17/9/03
	(b) Transplanting of seedlings (40days old)	27/9/03	7/10/03	17/10/03	27/10/03
[C]	**POST SOWING OPERATIONS :**				
13.	Gap filling in transplanted crop	4/10/03	15/10/03	22/10/03	5/11/03
14.	**Weeding**				
	(a) **Direct seeding :**				
	First	15/9/03	25/9/03	20/10/03	4/11/03
	Second	12/10/03	23/10/03	9/11/03	22/11/03
	Third	13/11/03	24/11/03	6/12/03	20/12/03
	(b) **Transplanting :**				
	First	19/10/03	30/10/03	9/11/03	17/11/03
	Second	7/11/03	12/11/03	28/11/03	7/12/03
15.	**Top dressing :**				
	(a) **Direct seeding :**				
	After 25 DAS	13/9/03	22/9/03	2/10/03	12/10/03
	After 45 DAS	3/10/03	12/10/03	22/10/03	2/11/03
	After 60 DAS	18/10/03	28/10/03	7/10/03	17/10/03
	(a) **Direct seeding :**				
	After 25 DATP	22/10/03	2/11/03	12/11/03	22/11/03
	After 45 DATP	12/11/03	22/11/03	2/12/03	12/12/03
	After 60 DAS	27/11/03	7/12/03	17/12/03	27/12/03
16.	**Plant protection :**				
	Spray of Endosulphan @ 0.07 %				
	First	5/10/03	5/10/03	5/10/03	5/10/03
	Second	20/11/03	20/11/03	20/11/03	20/11/03
	Spray of Blitox @ 30 g/liter				
	First	10/9/03	10/9/03	20/9/03	29/9/03
	Second	15/10/03	15/10/03	5/11/03	15/11/03

Table 4: Contd...

Sr. No	Field operations	Dates of operation			
		D_1	D_2	D_3	D_4
17.	**Direct seeding :**				
	1st	18/08/03	28/08/03	07 09 03	17 09 03
	2nd	23/08/03	02/09/03	12 09 03	22 09 0
	3rd	30/08/03	07/09/03	17 09 03	28 09 0
	4th	06/09/03	12/09/03	24 09 03	05 10 0
	5th	13/09/03	24/09/03	30 09 03	12 10 0
	6th	24/09/03	30/09/03	07 10 03	20 10 0
	7th	30/09/03	07/10/03	13 10 03	27 10 0
	8th	07/10/03	13/10/03	19 10 03	05 11 0
	9th	13/10/03	19/10/03	27 10 03	13 11 0
	10th	19/10/03	27/10/03	05 11 03	19 11 0
	11th	27/10/03	05/11/03	13 11 03	26 11 0
	12th	05/11/03	13/11/03	19 11 03	02 12 0
	13th	13/11/03	19/11/03	26 11 03	09 12 0
	14th	19/11/03	26/11/03	02 12 03	14 12 0
	15th	22/11/03	02/12/03	09 12 03	23 12 0
	16th	28/11/03	09/12/03	16/12/03	03/01/0
	17th	05/12/03	20/12/03	23/12/03	10/01/0
	18th	15/12/03	28/12/03	03/01/04	21/01/0
	19th	25/12/03	07/01/04	12/01/04	30/01/0
	20th	04/01/04	16/01/04	22/01/04	10/02/0
	21st	14/01/04	25/01/04	02/02/04	18/02/0
	22nd	24/01/04	15/02/04	12/02/04	28/02/0
	23rd	-	-	20/02/04	07/03/0
	Transplanting :				
	1st	27/09/03	07/10/03	19/10/03	27 10 03
	2nd	01/10/03	12/10/03	22/10/03	01 11 03
	3rd	05/10/03	17/10/03	27/10/03	06 11 03
	4th	10/10/03	22/10/03	02/11/03	12 11 03
	5th	15/10/03	28/10/03	07/11/03	18/11/03
	6th	20/10/03	04/11/03	12/11/03	25 11 03
	7th	26/10/03	10/11/03	18 11/03	01 12 03
	8th	01/11/03	16/11/03	26 11/03	07/12/0
	9th	08/11/03	22/11/03	03/12/03	14/12/0
	10th	16/11/03	28/11/03	09/12/03	21/12/0
	11th	23/11/03	06/12/03	15/12/03	28/12/0
	12th	28/11/03	16/12/03	22/12/03	05/01/0
	13th	02/12/03	23/12/03	30/12/03	10/01/0
	14th	12/12/03	30/12/03	07/01/04	18/01/0
	15th	22/12/03	09/01/04	15/01/04	24/01/0
	16th	31/12/03	18/01/04	24/01/04	03/02/0
	17th	10/01/04	27/01/04	03/02/04	12/02/0
	18th	19/01/04	06/02/04	12/02/04	22/02/0
	19th	28/01/04	17/02/04	21/02/04	01/03/0
	20th	12/02/04	24/02/04	01/03/04	10/03/0
	21st	-	-	10/03/04	19/03/0
18.	**Harvesting :**				
	Direct seeding	20th February	7th March	15th March	26th Marc
	Transplanting of seedlings	4th March	15th March	1st April	15th Apr

phosphate was applied per raised bed by broadcasting. Five grams seeds were sown on 18th August, 28th August, 7th September and 17th September 2003, respectively to raise the required number of seedlings for transplanting. The beds were covered with Bajra straw for a period of one week for better germination. The seedbeds were carefully irrigated to ensure better germination of seeds. Top dressing of 0.1 kg urea per raised bed was performed after 20 days of sowing. Necessary precautions were taken against pests and diseases.

3.7.3 Fertilizer application

Shallow furrows were opened manually in each plot in dry condition to apply recommended dose of fertilizers (100-50-50 kg NPK ha^{-1}). The entire quantity of phosphorus and potash was applied as basal dose at the time of sowing in form of Diammonium phosphate and Muriate of potash, respectively whereas Nitrogen was top-dressed in three equal splits at 25 DAS/DATP and 45 DAS/DATP and 60DAS/DATP.

3.7.4 Broadcasting of seeds and transplanting of seedlings

The onion seeds were broadcasted on 18th, 28th August, 7th and 17th September, 2003 in the respective beds, according to the recommended seed rate. Similarly, 40 days old healthy seedlings were used for transplanting on 27th September, 7th, 17th and 27th October, 2003 in the respective beds. These were raised in separate beds by broadcasting the seeds on 18th, 28th August, 7thand 17th September, respectively.

3.7.5 Post sowing operations

At the time of second irrigation gap filling was done by transplanting of seedlings of the same age in the transplanting treatments. Three and two common hand weedings were done in direct seeded and transplanted plots, respectively. The infestation of sucking pest was controlled by spraying the insecticide endosulphan 0.07 % @ 21ml/liter where as Alternaria blight was controlled by spraying the fungicide blitox @ 30g/10 liter.

3.7.6 Irrigation

First irrigation was applied carefully immediately after sowing, followed by second light irrigation at five days after the first irrigation for easy and uniform germination of seeds. Rests of the irrigations were given as and when required in direct seeded plots.

In case of transplanted onion, first irrigation was applied at the time of transplanting, second irrigation was given just after gap filling at five days after transplanting and remaining irrigations were applied as per crop need.

3.7.7 Harvesting

Harvesting was followed when the top shoots fall down over the ground and leaves became yellow and dried. The crop reached the stage of maturity ranging from 3rd week of February to 2nd week of April 2004. After marking the net plot area, the ring lines were harvested first and then the net plot area. Onion bulbs from direct seeded plots were dug out on 20th February, 7th March, 15th March and 26th March 2004 and from transplanted plots the bulbs were dug out on 4th March, 19th March, 1st April and 15th April 2004. After digging the

bulbs from soil the dried leaves and bottom roots were removed and hand rubbed for removing soil particles.

3.8 OBSERVATIONS :

Growth and yield attributing characters were recorded under field condition from each plot. Five plants were randomly selected and tagged in each of the experimental net plot for recording the individual plant observations. The following growth and yield attributing characters of plant were studied during the course of investigation are presented in Table 5.

3.9 PLANT POPULATION (Initial and at harvest) :

This was recorded after 15 days of sowing/transplanting and before harvesting of the crop from the net plot of each treatment by putting the square of iron rods in all the plots randomly for direct seeding.

Incase of transplanting plant population was counted manually from each net plot.

3.10 GROWTH CHARACTERS :

3.10.1 Plant height (cm)

Length of longest upright leaf up to the tip was measured in cm from ground level at 60 DAS/DATP and 90 DAS/DATP and at harvest in centimeters. Thus the height of each plant randomly selected from each treatment was recorded and mean values were worked out.

3.10.2 Number of leaves per plant

The number of leaves were counted periodically and recorded from randomly selected five plants from each treatment at 60 DAS/DATP and

Table 5 : Morphological parameters; yield attributes and yield of onion and biochemical studies during the investigation

Sr. No.	Characters	Sample size	Time of recording
1.	Initial plant population	Net plot	15 DAS/DATP
2.	Plant height (cm)	Five plants	60 DAS/DATP 90 DAS/DATP At harvest
3.	Number of leaves per plant	Five plants	60 DAS/DATP 90 DAS/DATP At harvest
4.	Neck thickness (cm)	Five plants	60 DAS/DATP 90 DAS/DATP At harvest
5.	Bolting per cent	Net plot	At harvest
6.	Jointed bulb per cent	Net plot	At harvest
7.	Final plant population	Net plot	At harvest
8.	Diameter of bulb (cm)	Five plants	After harvest
9.	Weight of bulb (g)	Five plants	After harvest
10.	Yield of onion bulb (q ha^{-1})	Net plot	After harvest
11.	Yield of onion straw (q ha^{-1})	Net plot	After harvest
12.	Dry matter per cent	Five plants	After harvest
13.	Total soluble solids per cent	Five plants	After harvest
14.	Grades of bulb (q ha^{-1})	Net plot	After harvest

90 DAS/DATP and at harvest. The average number of leaves per plant from each plot was worked out and recorded separately for all the treatments.

3.10.3 Neck thickness (cm)

The girth of randomly selected five plants was measured at 2.5 cm height from ground level in the field with the help of Vernier calipers and the mean values were worked out for each treatment.

3.10.4 Bolting per cent

The plants, which got flowers at harvest, were counted from each net plot by visual observation and converted into percentage on the basis of plant population at harvest.

3.10.5 Jointed bulb per cent

The jointed bulbs at harvest were counted visually from each net plot and converted in to percentage on the basis of plant population at harvest.

3.10.6 Maturity days

The maturity days were recorded on the basis of appearance of bulb maturity and falling of leaves on the ground. The maturity days were calculated from the date of sowing/transplanting of seedlings to maturity date. The mean values were considered. Number of days required from the date of sowing to the date of physiological maturity (*i.e.,* leaves turned yellow and started drying) was recorded as days to maturity for all the treatments.

3.11 YIELD AND YIELD ATTRIBUTES :

3.11.1 Diameter of bulb (cm)

The bulbs of five plants under observation were removed and then horizontal diameter was measured with the help of Vernier callipers, the mean diameter was then worked out and expressed in centimeter for each treatment.

3.11.2 Weight of bulb (g/bulb)

After recording the total weight of five bulbs, the mean weight of one bulb was worked out for each treatment and expressed in gram.

3.11.3 Yield of onion bulb (q ha^{-1})

Onion bulbs were dug out from each net plot at proper maturity stage when most of the top leaves fall down and dried. The bulbs after digging were kept under the shade for one week then all the dried leaves and bottom roots were removed and onion bulbs were weighed separately for each net plot area. The weight of five observational bulbs was also added to the net plot yield. Finally on the basis of per net plot bulb yield (kg $plot^{-1}$), the bulb yield (q ha^{-1}) was computed and recorded separately for each treatment.

3.11.4 Yield of onion straw (q ha^{-1})

Onion bulbs were dug out from the soil at proper maturity stage when most of the top leaves fall down and dried. All the dried leaves were removed after one week of digging the bulbs and weighed separately for each net plot area. The weight of dried leaves of five observational plants was also added to the net plot yield. Finally on the basis of per net plot straw yield (kg $plot^{-1}$), the straw yield (q ha^{-1}) was computed and recorded separately for each treatment.

3.11.5 Dry matter per cent and Dry matter yield (q ha^{-1})

For estimating dry matter accumulation, the onion bulbs were cut into small pieces; sun dried and then kept in oven at 60°C for drying till constant weight was obtained. The dry matter was calculated on the basis of final dry weight and initial fresh weight and was expressed in percentage for each treatment. Dry matter yield was calculated by using the following equation :

$$\text{Dry matter yield (q ha}^{-1}\text{)} = \frac{\text{Per cent dry matter x bulb yield (q ha}^{-1}\text{)}}{100}$$

3.11.6 Bulb grades (per cent) as per diameter

After measuring diameter of bulb, the onion bulbs were categorized in three grades *i.e.*

(a) Greater than 5.5 cm : A grade

(b) 4.5 to 5.5 cm : B grade

(c) Less than 4.5 cm : C grade

3.12 BIO-CHEMICAL STUDIES :

3.12.1 Total soluble solids (per cent)

For the estimation of total soluble solids, five onion bulbs from each treatment were cut in to small pieces and mixed thoroughly to make homogeneous extract. Five readings were recorded with the help of pocket hand refractometer. The mean total soluble solids in percentage was worked out and recorded for each treatment.

3.13 STATISTICAL ANALYSIS :

The statistical analysis of the data for different characters was carried out as per the procedure given by Panse and Sukhatme (1967) on computer according to design of the experiment.

Summary tables for treatment effects are prepared and presented with standard error of mean (S.Em.) at five per cent level of probability where the treatment effects were found significant.

3.14 ECONOMICS :

The gross realization in terms of rupees per hectare was worked out for each treatment on the basis of the onion bulb yield and prevailing market price of onion bulb. The cost of cultivation of the crop for each treatment was worked out taking into consideration the cost of all inputs and operations, from preparatory tillage to harvesting. The net realization was worked out by deducting the total cost of cultivation from the gross realization for each treatment and recorded in rupees per hectare. The cost benefit ratio (C.B.R.) was calculated on the basis of the formula given below :

$$\text{Cost Benefit Ratio} = \frac{\text{Total Realization (Rs.)}}{\text{Total Expenditure (Rs.)}}$$

EXPERIMENTAL RESULTS

IV. EXPERIMENTAL RESULTS

Results of the field experiment entitled "Response of direct seeded and transplanted onion (*Allium cepa* L.) to dates of sowing in *kharif* season under North Gujarat condition" are presented in this chapter. The data pertaining to the growth parameters, yield attributes, yield and quality characters were subjected to statistical analysis for the test of significance of the results. The analysis of variance for treatment evaluation has been given in the appendices from I to V along with the level of significance. Data on all main effects and only significant interactions are presented in the succeeding paragraphs wherever necessary the results have also been depicted graphically.

4.1 PLANT POPULATION :

The data on initial and final plant population are presented in Table 6. The analysis of variance is furnished in Appendix–I.

Effect of dates of sowing

The data presented in Table 6 revealed that the initial as well as final plant population was not significantly influenced due to different dates of sowing, indicating uniform plant population in all the dates of sowing, without any adverse effect of the treatments.

Effect of methods of sowing

The initial and final plant population was significantly influenced due to methods of sowing as evident from Table 6. Significantly higher plant

Table 6 : Initial and final plant population of onion as influenced by dates and methods of sowing

Treatment	Plant population (plants ha^{-1})	
	Initial (15 DAS/DATP)	Final (At harvest)
Dates of sowing (D) :		
D_1 : 18th August	698785	689670
D_2 : 28th August	703125	690972
D_3 : 7th September	701822	692274
D_4 : 17th September	690972	682291
S.Em. ±	7706	6831
C.D. at 5 %	NS	NS
Methods of sowing (S) :		
S_1 : Direct seeding	731119	721571
S_2 : Transplanting	666233	656033
S.Em. ±	4955	4830
C.D. at 5 %	14574	14208
C.V. %	2.84	2.81
Interaction :		
(D × S)	NS	NS

population was observed with treatment S_1 (direct seeding) as compared to S_2 (transplanting).

Effect of interaction

The interaction effect of dates and methods of sowing was not found significant on initial and final plant population.

4. 2 GROWTH CHARACTERS :

4.2.1 Plant height

The data on the effect of dates and methods of sowing on plant height recorded at 60 DAS/DATP, 90 DAS/DATP and at harvest are presented in Table 7 and graphically depicted in Fig.3. The analysis of variance is furnished in Appendix-I.

Effect of dates of sowing

Data presented in Table 7 indicated that the plant height was significantly influenced due to dates of sowing. Treatment D_1 (18^{th} Aug.) remaining at par with D_2 (28^{th} Aug.) recorded significantly higher plant height as compared to treatment D_3 (7^{th} Sept.) and D_4 (17^{th} Sept.) at 60 DAS/DATP. Treatment D_4 (17^{th} Sept.) measured significantly lower plant height than treatment D_2 (28^{th} Aug.) but it remained at par with treatment D_3 (7^{th} Sept.) at 60 DAS/DATP (Fig. 3). At 90 DAS /DATP, treatment D_1 (18^{th} Aug.) recorded significantly the highest plant height but treatment D_2 (28^{th} Aug.) and D_3 (7^{th} Sept.) exerted statistically equal effect on plant height. Treatment D_2 (28^{th} Aug.) and D_3 (7^{th} Sept.) produced significantly taller plants than that of treatment D_4 (17^{th} Sept.) at 90 DAS/DATP. Treatment D_1 (18^{th} Aug.) recorded

Table 7 : Plant height of onion as influenced by dates and methods of sowing

Treatment	Plant height (cm)		
	60 DAS/DATP	90 DAS/DATP	At harvest
Dates of sowing (D) :			
D_1 : 18th August	29.5	66.4	58.7
D_2 : 28th August	27.9	61.0	51.9
D_3 : 7th September	24.4	59.5	50.3
D_4 : 17th September	23.7	55.3	46.1
S.Em. ±	0.8	1.3	0.2
C.D. at 5 %	2.3	3.9	0.6
Methods of sowing (S) :			
S_1 : Direct seeding	23.8	58.1	49.0
S_2 : Transplanting	29.0	63.1	54.5
S.Em. ±	0.6	1.0	0.2
C.D. at 5 %	1.6	2.8	0.4
C.V. %	8.3	6.1	7.4
Interaction :			
(D × S)	NS	NS	NS

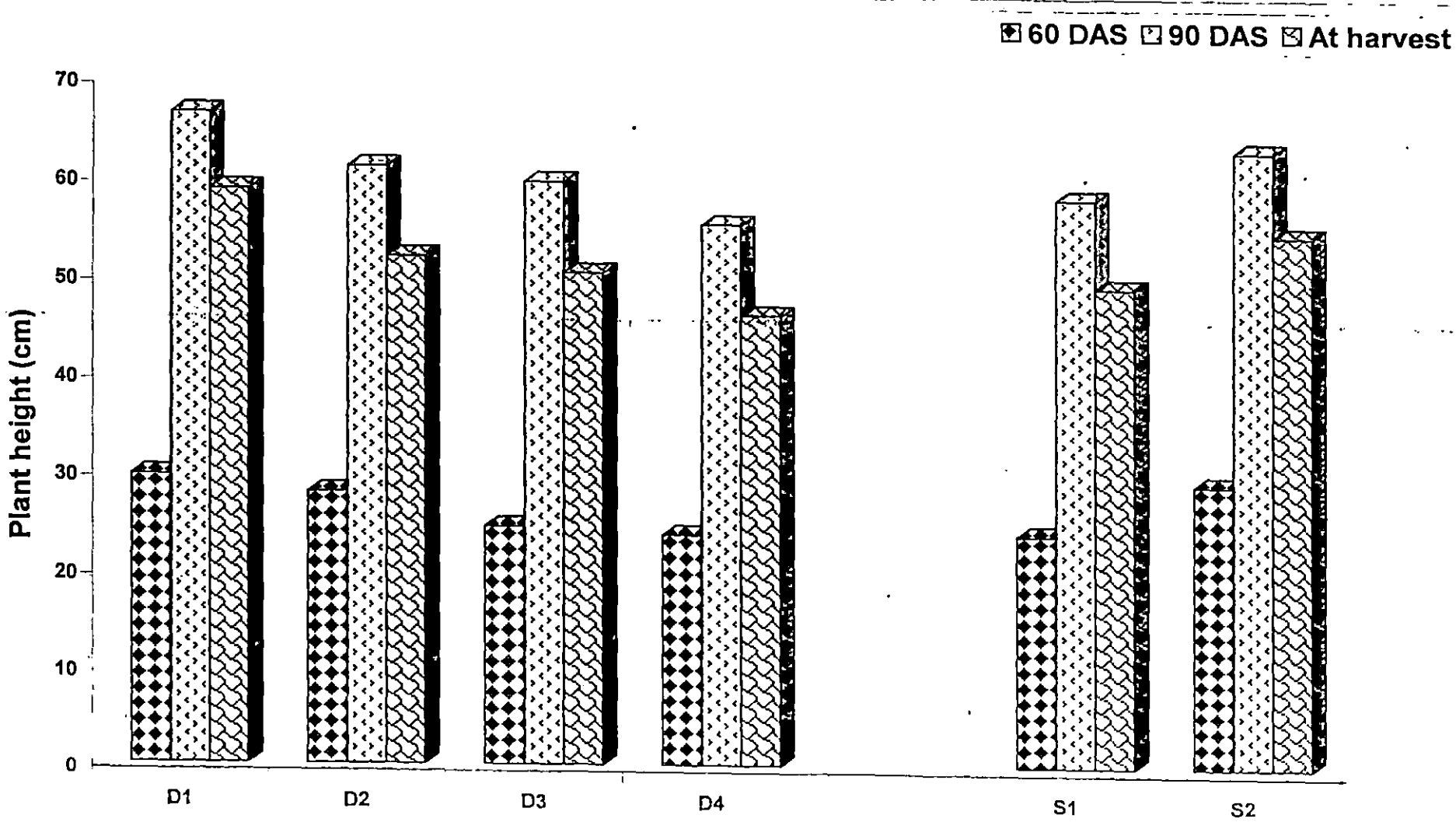


Fig. 3 : Plantheight as influenced by dates and methods of sowing

significantly higher plant height as compared to rest of the sowing dates at harvest. Treatment D_2 (28th Aug.), D_3 (7th Sept.) and D_4(17th Sept.) differed significantly from each other and exerted their effect on plant height in decreasing order.

Effect of methods of sowing

The data on plant height as influenced by methods of sowing at different stages are presented in Table 7. Treatment S_2 (transplanting) recorded significantly higher plant height as compared to treatment S_1 (direct seeding) at 60 DAS/ DATP, 90 DAS/ DATP and at harvest as evident from Fig. 3.

Effect of interaction

The interaction effect of dates and methods of sowing with respect to plant height at 60 DAS/ DATP, 90 DAS/DATP and at harvest was not found significant.

4.2.2 Number of leaves per plant

The data pertaining to number of leaves per plant at 60 DAS/ DATP, 90 DAS/DATP and at harvest as affected by different dates and methods of sowing are presented in Table 8 and graphically depicted in Fig. 4. The analysis of variance is given in Appendix-I.

Effect of dates of sowing

The results revealed that the differences in number of leaves per plant at different growth stages were significantly influenced by dates of sowing. Treatment D_1 (18th Aug.) recorded significantly the highest number of leaves per plant at 60 DAS/DATP and at harvest (Fig. 4). The second best treatment

Table 8 : Number of leaves per plant of onion as influenced by dates and methods of sowing

Treatment	Number of leaves per plant		
	60 DAS/DATP	90 DAS/DATP	At harvest
Dates of sowing (D) :			
D_1 : 18th August	5.9	8.6	6.2
D_2 : 28th August	5.4	7.9	5.5
D_3 : 7th September	5.1	7.2	5.0
D_4 : 17th September	4.8	7.1	4.8
S.Em. ±	0.1	0.2	0.2
C.D. at 5 %	0.4	0.6	0.6
Methods of sowing (S) :			
S_1 : Direct seeding	5.0	7.4	5.0
S_2 : Transplanting	5.7	8.0	5.7
S.Em. ±	0.1	0.6	0.1
C.D. at 5 %	0.3	0.4	0.4
C.V. %	7.4	7.4	10.1
Interaction :			
(D × S)	NS	NS	NS

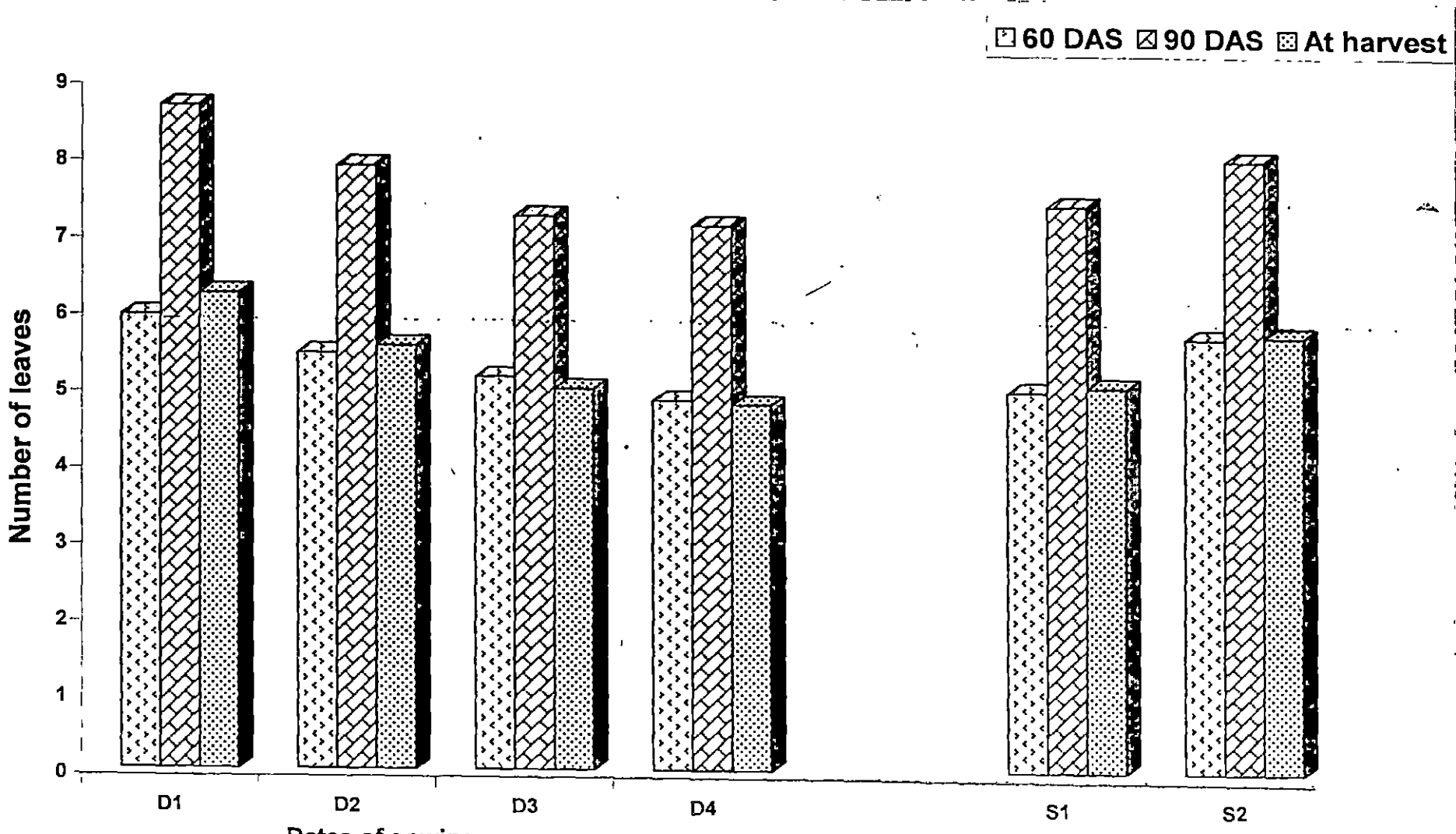


Fig. 4 : Number of leaves per plant as influenced by dates and methods of sowing

D_2 (28th Aug.) registered significantly higher number of leaves per plant than that of treatment D_4(17th Sept.) but it remained at par with D_3 (7th Sept.) at 60 DAS/DATP and at harvest. At 90 DAS/DATP, treatment D_2 (28th Aug.) recorded significantly higher number of leaves per plant as compared to treatment D_3 (7th Sept.) and D_4 (17th Sept.) but the latter two did not differ significantly from each other.

Effect of methods of sowing

The data on number of leaves per plant at 60 DAS/DATP, 90 DAS/DATP and at harvest as influenced by methods of sowing are presented in Table 8. The results indicated that treatment S_2 (transplanting) recorded significantly higher number of leaves per plant as compared to treatment S_1 (direct seeding) at 60 DAS/DATP, 90 DAS/DATP and at harvest (Fig. 4).

Effect of interaction

The interaction effect of different dates and methods of sowing on number of leaves per plant at 60 DAS/DATP, 90 DAS/DATP and at harvest were not found significant.

4.2.3 Neck thickness

Data pertaining to neck thickness at 60 DAS/DATP, 90 DAS/DATP and at harvest as influenced by different dates and methods of sowing are furnished in Table 9 and also graphically depicted in Fig.5. The analysis of variance is given in Appendix-I.

Effect of dates of sowing

The data presented in Table 9 indicated that the differences in neck thickness were significantly influenced by the dates of sowing. Treatment D_1 (18^{th} Aug.) remaining at par with D_2 (28^{th} Aug.) produced significantly higher neck thickness than that of treatment D_3 (7^{th} Sept.) and D_4(17^{th} Sept.) at 60 DAS/DATP and 90 DAS/DATP. Significantly the highest neck thickness was recorded with treatment D_1 (18^{th} Aug.) at harvest. Treatment D_2 (28^{th} Aug.), D_3 (7^{th} Sept.) and D_4 (17^{th} Sept.) differed significantly from each other and exerted their effects in descending order on neck thickness at harvest (Fig.5).

Effect of methods of sowing

The data on neck thickness as influenced by methods of sowing are presented in Table 9. Treatment S_2 (transplanting) recorded significantly higher neck thickness as compared to treatment S_1 (direct seeding) at 60 DAS/DATP, 90 DAS/DATP and at harvest (Fig. 5).

Effect of interaction

The interaction effect of dates and methods of sowing was not found significant on neck thickness at 60 DAS/DATP, 90 DAS/DATP and at harvest.

4.2.4 Bolting per cent

The data regarding effect of dates and methods of sowing on bolting per cent of onion are presented in Table 10 and also graphically depicted in Fig.6. The analysis of variance is given in Appendix-II.

Table 9 : Neck thickness of onion plant as influenced by dates and methods of sowing

Treatment	Neck thickness (cm)		
	60 DAS/DATP	90 DAS/DATP	At harvest
Dates of sowing (D) :			
D_1 : 18th August	0.71	1.23	0.70
D_2 : 28th August	0.66	1.17	0.61
D_3 : 7th September	0.65	1.08	0.53
D_4 : 17th September	0.62	0.98	0.46
S.Em. ±	0.02	0.03	0.02
C.D. at 5 %	0.05	0.08	0.05
Methods of sowing (S) :			
S_1 : Direct seeding	0.56	1.05	0.51
S_2 : Transplanting	0.76	1.18	0.64
S.Em. ±	0.02	0.02	0.02
C.D. at 5 %	0.04	0.06	0.04
C.V. %	6.40	6.59	7.17
Interaction :			
(D × S)	NS	NS	NS

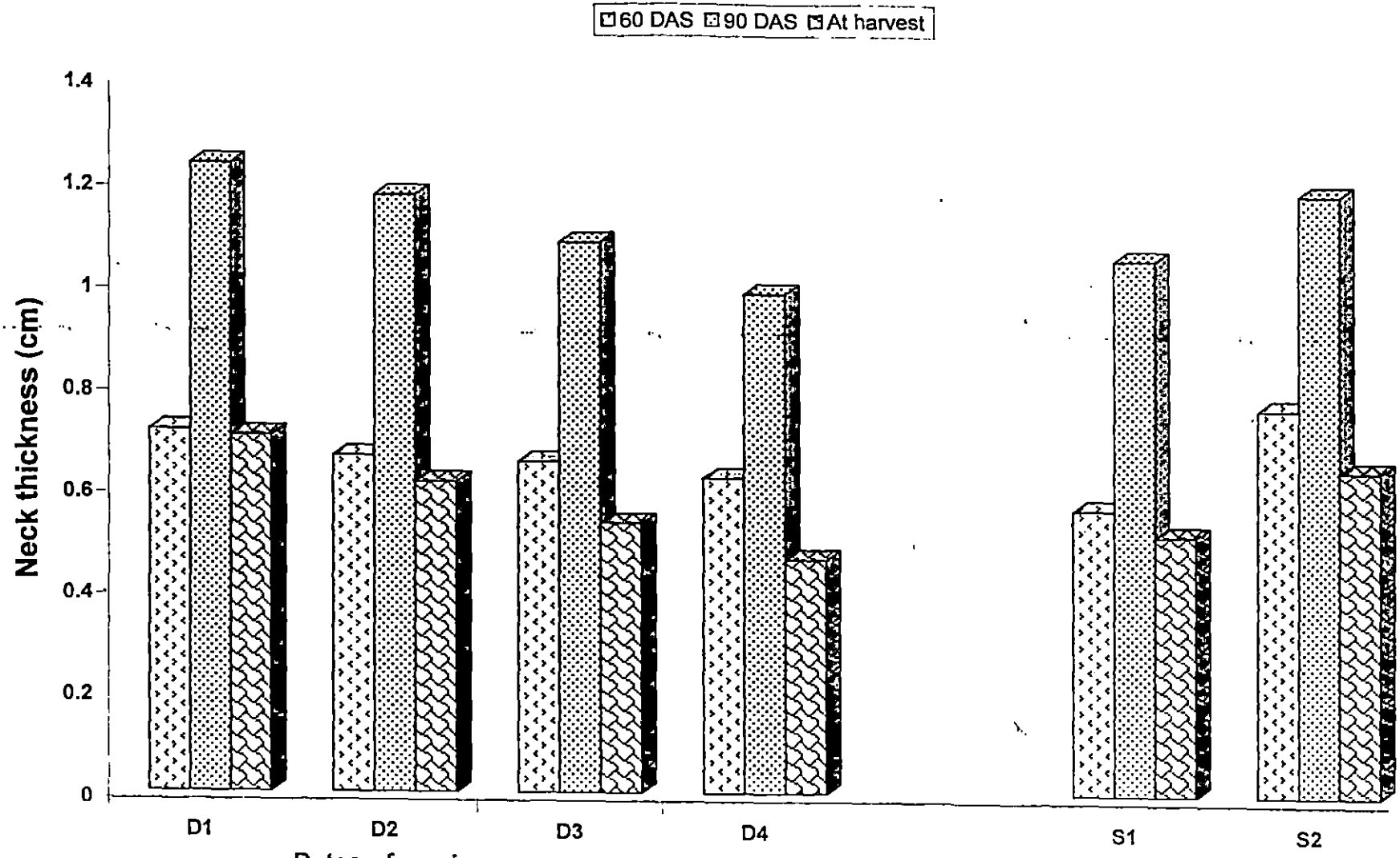


Fig. 5 : Neck thickness of onion plant as influenced by dates and methods of sowing

Effect of dates of sowing

The data presented in Table 10 revealed that the differences in bolting per cent were significantly influenced due to different dates of sowing. Significantly the highest bolting per cent (41.2) was noticed in treatment D_4 (17^{th} Sept.) as evident from Fig.6. The treatment D_3 (7^{th} Sept.) remaining at par with treatment D_2 (28^{th} Aug.) recorded significantly higher bolting per cent (29.0) than treatment D_1 (18^{th} Aug.). Treatment D_1 (18^{th} Aug.) remained statistically at par with D_2 (28^{th} Aug.) in terms of bolting per cent.

Effect of methods of sowing

The data presented in Table 10 indicated that methods of sowing did not exert significant effect on bolting per cent of onion.

Effect of interaction

The interaction effect of dates and methods of sowing on bolting per cent was not found significant.

4.2.5 Jointed bulb per cent

Data regarding the effect of dates and methods of sowing on jointed bulb per cent are presented in Table 10 and graphically depicted in Fig. 6. The analysis of variance is furnished in Appendix-II.

Effect of dates of sowing

An appraisal of data presented in Table 10 revealed that the effect of different dates of sowing on jointed bulb per cent was not found significant (Fig. 6).

Table 10 : Bolting per cent, jointed bulb per cent and days to maturity of onion as influenced by dates and methods of sowing

Treatment	Bolting per cent	Jointed bulb per cent	Days to maturity
Dates of sowing (D) :			
D_1 : 18th August	22.8	4.1	173
D_2 : 28th August	26.8	4.5	179
D_3 : 7th September	29.0	4.6	180
D_4 : 17th September	41.2	5.4	182
S.Em. ±	2.0	0.3	1.6
C.D. at 5 %	5.9	NS	4.6
Methods of sowing (S) :			
S_1 : Direct seeding	30.5	5.6	190
S_2 : Transplanting	29.3	3.7	166
S.Em. ±	1.4	0.2	1.1
C.D. at 5 %	NS	0.7	3.3
C.V. %	18.6	20.5	2.5
Interaction :			
(D × S)	NS	NS	NS

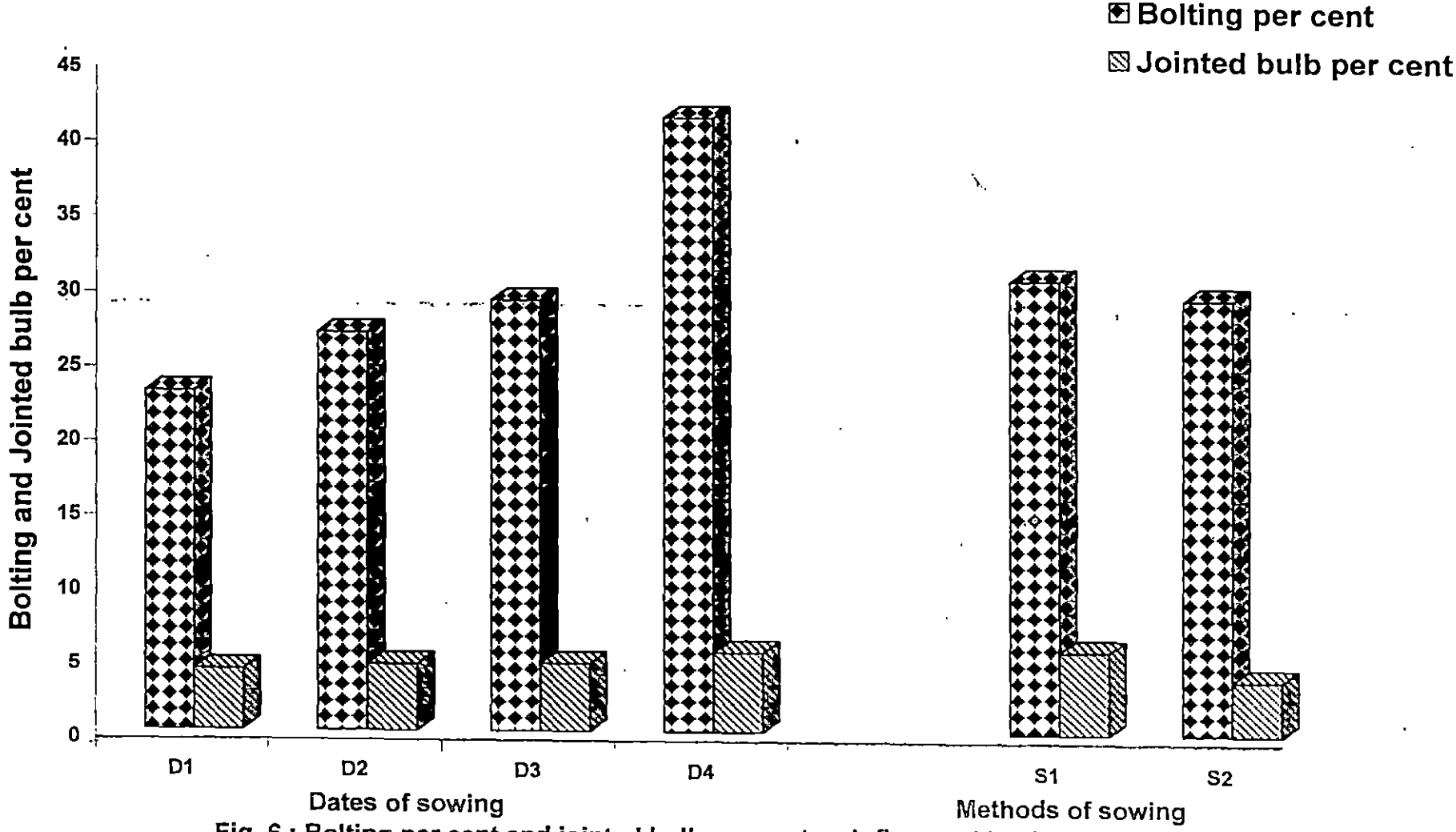


Fig. 6 : Bolting per cent and jointed bulb per cont as influenced by dates and

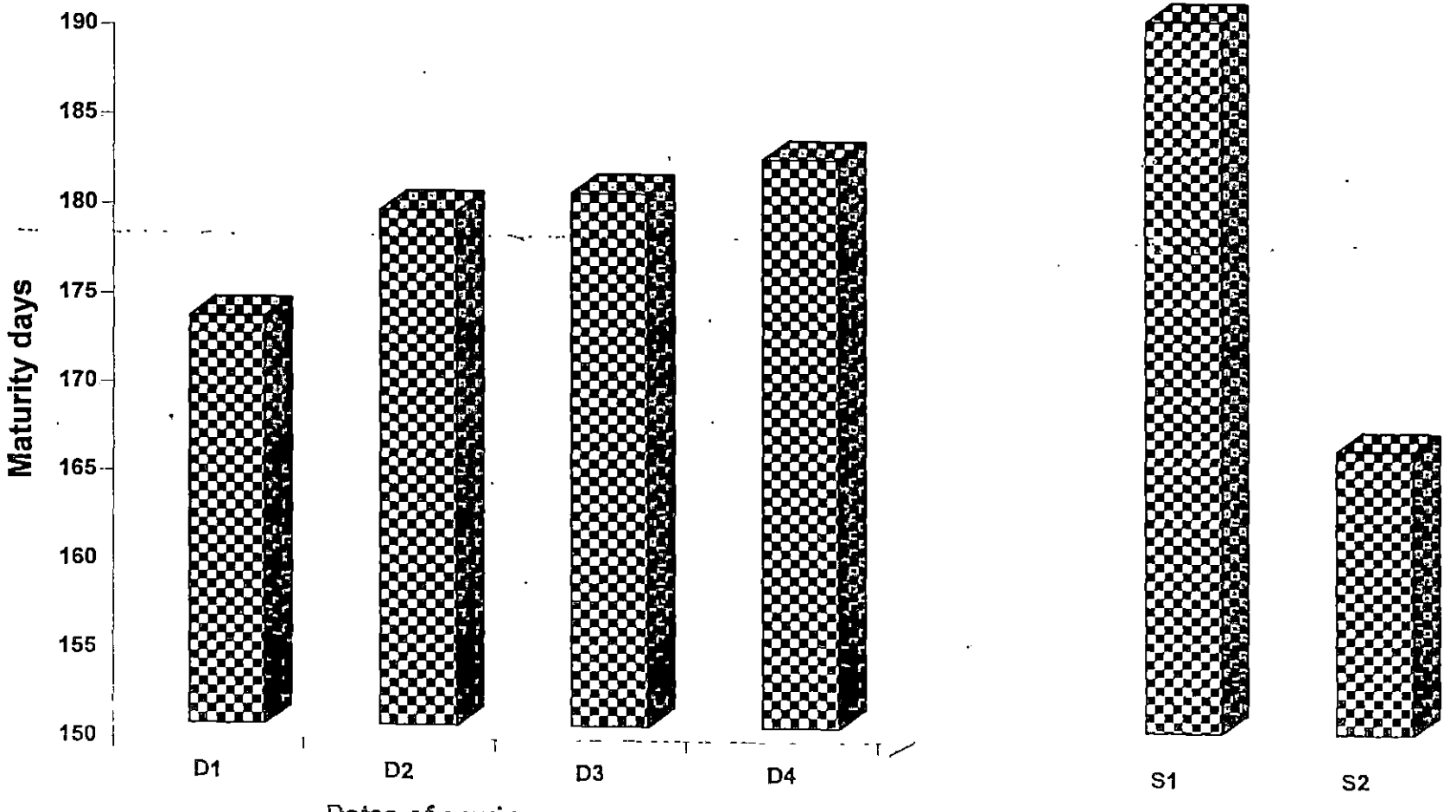


Fig. 7 : Days to maturity of onion as influenced by dates and methods of sowing

Effect of methods of sowing

An examination of data given in Table 10 indicated that the differences in jointed bulb per cent were significantly influenced by methods of sowing. Significantly higher jointed bulb per cent (5.6) were recorded with treatment S_1 (direct seeding) than that of treatment S_2 (transplanting) as illustrated in Fig. 6.

Effect of interaction

The interaction effect of dates and methods of sowing on jointed bulb per cent of onion was not found significant.

4.2.6 Days to maturity

The data regarding the effect of dates and methods of sowing on days to maturity are presented in Table 10 and graphically depicted in Fig. 7. The analysis of variance is furnished in Appendix-II.

Effect of dates of sowing

Perusal of data presented in Table 10 indicated that days to maturity were significantly influenced due to dates of sowing. Treatment D_1 (18^{th} Aug.) required minimum number of days (173) for maturity while treatment D_4 (17^{th} Sept.) required maximum number of days (182) for maturity of onion. The treatment D_2 (28^{th} Aug.), D_3 (7^{th} Sept.) and D_4 (17^{th} Sept.) did not differ significantly from each other in respect of days to maturity. Treatment D_1 (18^{th} Aug.) took significantly the lowest number of days for maturity of onion (Fig.7).

Effect of methods of sowing

It is evident from Table 10 and Fig. 7 that treatment S_1 (direct seeding) required significantly more number of days (190) to maturity than S_2 *i.e.*, transplanting (166 days).

Effect of interaction

The interaction effect of dates and methods of sowing on days to maturity was not found significant.

4.3 YIELD AND YIELD ATTRIBUTES :

4.3.1 Diameter of bulb (cm)

Data regarding the effect of dates and methods of sowing on diameter of onion bulb are furnished in Table 11 and graphically projected in Fig. 8. The analysis of variance is given in Appendix-III.

Effect of dates of sowing

Perusal of data presented in Table 11 revealed that treatment D_1 (18^{th} Aug.) remaining at par with D_2 (28^{th} Aug.) recorded significantly higher bulb diameter as compared to treatment D_3 (7^{th} Sept.) and D_4 (17^{th} Sept.). Significantly the lowest diameter of bulb was registered with treatment D_4 (17^{th} Sept.). Treatment D_3 (7^{th} Sept.) remained at par with treatment D_2 (28^{th} Aug.). The increase in diameter of bulb noted under treatment D_1 (18^{th} Aug.) was 7.64, 15.83 and 29.89 per cent than treatment D_2 (28^{th} Aug.), D_3 (7^{th} Sept.) and D_4 (17^{th} Sept.) respectively (Fig.8).

Table 11 : Diameter and weight of bulb at harvest as influenced by dates and methods of sowing

Treatment	Diameter of bulb (cm)	Weight of bulb per plant (g)
Dates of sowing (D) :		
D_1 : 18th August	5.78	76.2
D_2 : 28th August	5.37	69.4
D_3 : 7th September	4.99	65.7
D_4 : 17th September	4.45	61.4
S.Em. ±	0.15	2.2
C.D. at 5 %	0.44	6.3
Methods of sowing (S) :		
S_1 : Direct seeding	4.65	57.5
S_2 : Transplanting	5.64	78.6
S.Em. ±	0.11	1.5
C.D. at 5 %	0.31	4.5
C.V. %	8.07	9.0
Interaction :		
(D×S)	NS	NS

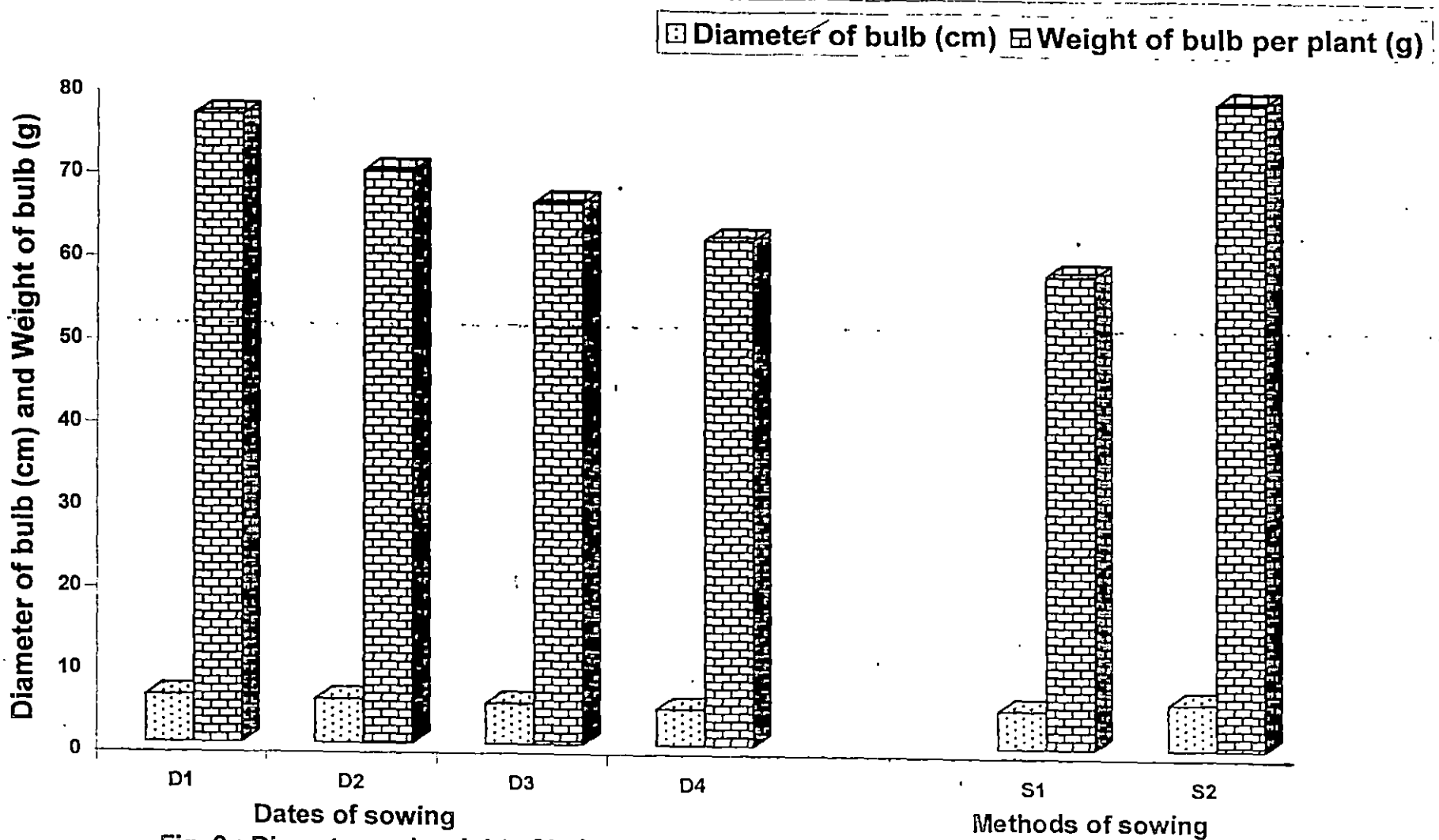


Fig. 8 : Diameter and weight of bulb at harvest as influenced by dates and methods of sowing

Effect of methods of sowing

The results summarized in Table 11 revealed that the diameter of bulb was significantly influenced by methods of sowing. Significantly greater diameter of bulb (5.64 cm) was recorded with treatment S_2 (transplanting) than that of S_1 (direct seeding) with 4.65 cm (Fig. 8).

Effect of interaction

The interaction effect of dates and methods of sowing was not found significant on diameter of onion bulb.

4.3.2 Weight of bulb per plant (g)

The data pertaining to average weight of onion bulb (g) as influenced by different dates and methods of sowing are given in Table 11 and graphically depicted in Fig. 8. The analysis of variance is given in Appendix-III.

Effect of dates of sowing

The data presented in Table 11 indicated that the effect of different dates of sowing on weight of onion bulb was found significant. Treatment D_1 (18^{th} Aug.) recorded significantly the highest weight of bulb (76.2 g). Treatment D_2 (28^{th} Aug.) remained at par with treatment D_3 (7^{th} Sept.) but it produced more weight of bulb (65.7 g) than treatment D_4(17^{th} Sept.) *i.e.*, 61.4 g. The increase in weight of bulb noted under treatment D_1 (18^{th} Aug.) was to the tune of 9.8, 16.0 and 24.1 per cent over treatment D_2 (28^{th} Aug.), D_3 (7^{th} Sept.) and D_4 (17^{th} Sept.) respectively (Fig. 8).

Effect of methods of sowing

The data on weight of onion bulb at harvest as influenced by methods of sowing are summarized in Table 11. Treatment S_2 (transplanting) recorded significantly higher bulb weight (78.6 g) as compared to direct seeding (57.5 g) as illustrated in Fig. 8.

Effect of interaction

The interaction effect of dates and methods of sowing on weight of onion bulb was not found significant.

4.3.3 Yield of onion bulb (q ha^{-1})

The mean data on bulb yield as affected by different dates and methods of sowing are presented in Table 12 and graphically illustrated in Fig. 9. The analysis of variance is given in Appendix-III.

Effect of dates of sowing

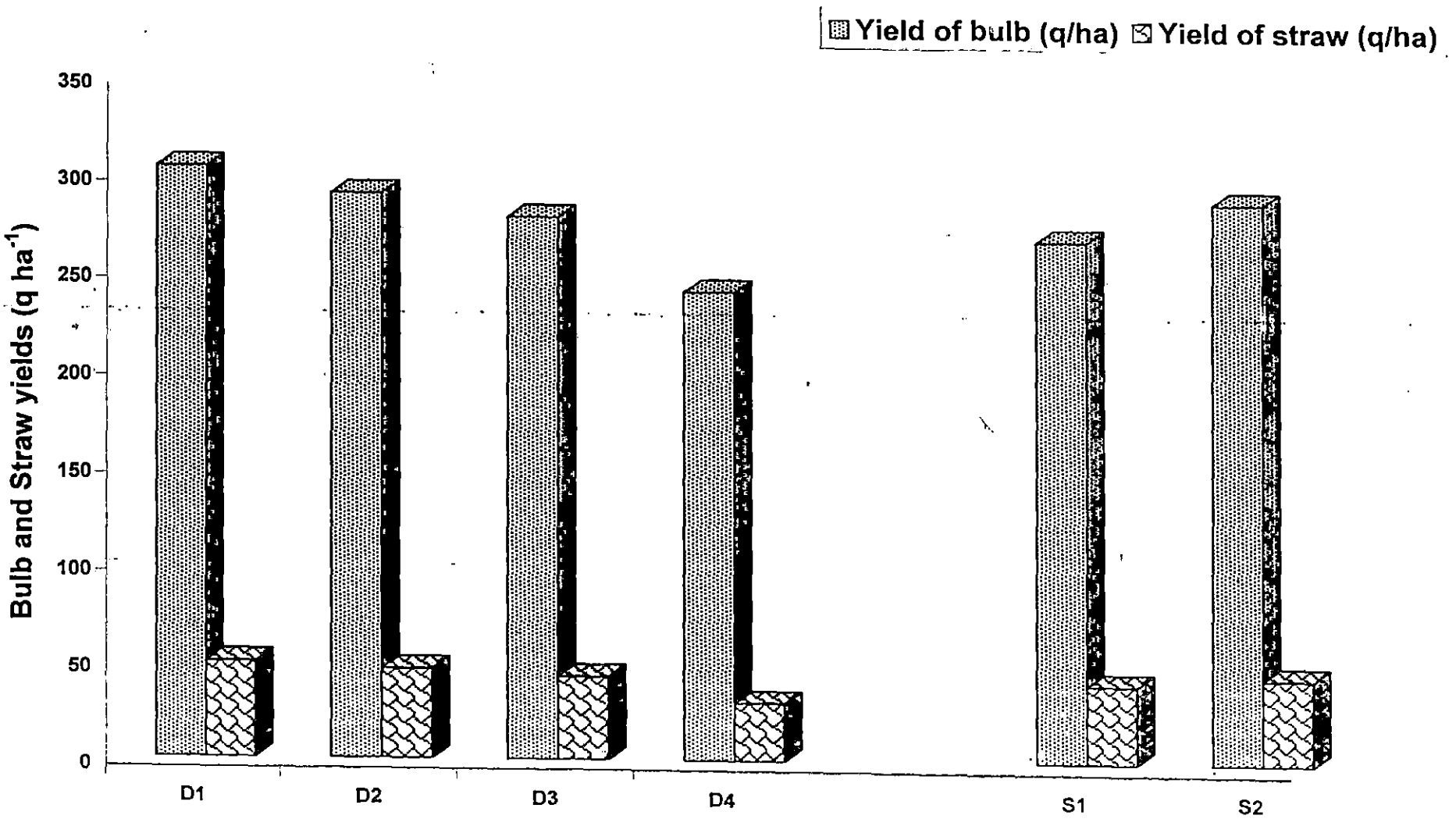
Data in Table 12 indicated that the bulb yield of onion was significantly influenced by different dates of sowing. All the four dates expressed individual effect on bulb yield. Treatment D_1 (18^{th} Aug.) recorded significantly the highest bulb yield (303.3 q ha^{-1}) where as treatment D_4 (17^{th} Sept.) produced significantly the lowest bulb yield (240.6 q ha^{-1}). In term of yield the behaviour of treatments was D_1 (18^{th}Aug.) > D_2 (28^{th}Aug.) > D_3 (7^{th} Sept.) >D_4 (17^{th} Sept.) as projected in Fig. 9.

Effect of methods of sowing

The data presented in Table 12 revealed that the methods of sowing significantly influenced the bulb yield of onion. Significantly higher yield of

Table 12 : Bulb, straw and total yield of onion as influenced by dates and methods of sowing

Treatment	Yield of bulb (q ha^{-1})	Yield of straw (q ha^{-1})	Total yield (q ha^{-1})
Dates of sowing (D) :			
D_1 : 18th August	303.3	49.3	352.6
D_2 : 28th August	290.3	46.2	336.5
D_3 : 7th September	278.7	42.8	321.4
D_4 : 17th September	240.6	29.8	270.4
S.Em. ±	3.6	1.2	4.5
C.D. at 5 %	10.4	3.4	13.2
Methods of sowing (S) :			
S_1 : Direct seeding	268.1	40.1	308.1
S_2 : Transplanting	288.4	44.0	332.4
S.Em. ±	2.5	0.9	3.2
C.D. at 5 %	7.3	2.4	9.3
C.V. %	3.6	7.8	4.0
Interaction :			
(D × S)	NS	NS	NS


Yield of bulb (q/ha)
Yield of straw (q/ha)
Bulb and Straw yields (q ha-1)
350
300
250
200
150
100
50
0
D1
D2
D3
D4
S1
S2

288.4 q ha^{-1} was recorded with S_2 (transplanting) than S_1 *i.e.*, direct seeding (268.1 q ha^{-1}).

Effect of interaction

The interaction effect of dates and methods of sowing was not found significant on bulb yield of onion.

4.3.4 Straw yield (q ha^{-1})

Data on the effect of different dates and methods of sowing on straw yield of onion are presented in Table 12 and depicted graphically in Fig. 9. Analysis of variance is given in Appendix-III.

Effect of dates of sowing

Data presented in Table 12 indicated that treatment D_1 (18^{th} Aug.) remaining at par with treatment D_2 (28^{th} Aug.) produced significantly higher straw yield (49.3 q ha^{-1}) as compared to treatment D_3 (7^{th} Sept.) and D_4 (17^{th} Sept.). Treatment D_4 recorded significantly the lowest yield of 29.8 q ha^{-1}. Treatment D_2 (28^{th} Aug.) remained at par with D_3 (7^{th} Sept.) in respect of straw yield.(Fig. 9).

Effect of methods of sowing

The data on straw yield of onion as influenced by methods of sowing are given in Table 12. Treatment S_2 (transplanting) recorded significantly higher straw yield (44.0 q ha^{-1}) as compared to S_1 (direct seeding) bearing the value of 40.1 q ha^{-1} (Fig. 9).

Effect of interaction

The interaction effect of dates and methods of sowing on straw yield of onion was not found significant.

4.3.5 Total yield (q ha^{-1})

The data pertaining to total yield of onion as influenced by dates and methods of sowing are given in Table 12. The analysis of variance is furnished in Appendix-III.

Effect of dates of sowing

The data presented in Table 12 revealed that the different dates of sowing significantly influenced the total yield of onion. Treatment D_1 (18^{th} Aug.) recorded significantly the highest total yield of onion (352.6 q ha^{-1}) while the lowest yield of 270.4 q ha^{-1} with D_4 (17^{th} Sept.). All the four dates expressed individual but significant effect on total yield remaining in the order of D_1 (18^{th} Aug.) > D_2 (28^{th} Aug.) > D_3 (7^{th} Sept.) > D_4 (17^{th} Sept.).

Effect of methods of sowing

The data summarized in Table 12 indicated that the methods of sowing influenced the total yield of onion. Treatment S_2 (transplanting) produced significantly higher total yield (322.4 q ha^{-1}) than treatment S_1 (direct seeding) bearing the value of 308.1 q ha^{-1}.

Effect of interaction

The interaction effect of dates and methods of sowing on total yield was not found significant.

4.3.6 Dry matter per cent

The data regarding the effect of dates and methods of sowing on dry matter per cent at harvest are presented in Table 13. The analysis of variance is given in Appendix-III.

Effect of dates of sowing

The data presented in Table 13 indicated that the effect of different dates of sowing on dry matter per cent at harvest was found significant. Significantly the highest dry matter per cent (15.9) was recorded with treatment D_1 (18^{th} Aug.). Treatment D_2 (28^{th} Aug.) contained significantly lower dry matter (14.4) than treatment D_1 (18^{th} Aug.) but higher than treatment D_3 (7^{th} Sept.) and D_4 (17^{th} Sept.). Treatment D_3 (7^{th} Sept.) and D_4 (17^{th} Sept.) did not differ significantly from each other.

Effect of methods of sowing

The data presented in Table 13 indicated that the effect of methods of sowing on dry matter per cent at harvest was not found significant.

Effect of interaction

The interaction effect of dates and methods of sowing on dry matter per cent of onion was not found significant.

4.3.7 Dry matter yield (q ha^{-1})

The data regarding the influence of different dates and methods of sowing on dry matter yield of onion (q ha^{-1}) are summarized in Table 13. Analysis of variance is presented in Appendix –III.

Table 13 : Dry matter per cent and dry matter yield of onion as influenced by dates and methods of sowing

Treatment	Dry matter (%)	Dry matter yield (q ha^{-1})
Dates of sowing (D) :		
D_1 : 18th August	15.9	48.4
D_2 : 28th August	14.4	41.8
D_3 : 7th September	13.3	37.2
D_4 : 17th September	13.2	31.7
S.Em. ±	0.4	1.2
C.D. at 5 %	1.0	3.6
Methods of sowing (S) :		
S_1 : Direct seeding	13.9	37.2
S_2 : Transplanting	14.5	42.2
S.Em. ±	0.3	0.9
C.D. at 5 %	NS	2.6
C.V. %	6.9	8.7
Interaction :		
(D × S)	NS	NS

Effect of dates of sowing

Perusal of data presented in Table 13 indicated that the treatment D_1 (18^{th} Aug.) produced significantly the highest dry matter yield of 48.4 q ha^{-1}. All the four dates behaved differently from each other remaining in the order of D_1 (18^{th} Aug.) > D_2 (28^{th} Aug.) > D_3 (7^{th} Sept.) > D_4 (17^{th} Sept.). Significantly the lowest dry matter yield of 31.7 q ha^{-1} was produced by treatment D_4 (27^{th} Sept.).

Effect of methods of sowing

An appraisal of data given in Table 13 indicated that the effect of methods of sowing on dry matter yield of onion was found significant. Significantly higher dry matter yield was recorded with treatment S_2 (transplanting) as compared to S_1 (direct seeding). Treatment S_2 (transplanting) produced 13.4 per cent higher dry matter yield than S_1 (direct seeding).

Effect of interaction

The interaction effect of dates and methods of sowing on dry matter yield was not found significant.

4.3.8 Grade of onion bulb (q ha^{-1})

The data pertaining to bulb grades per cent as affected by dates and methods of sowing are furnished in Table 14. The analysis of variance is given in Appendix-III.

Effect of dates of sowing

The dates of sowing had significant effect on bulb grades.

Table 14 : Yield of different grades of onion bulb as influenced by dates and methods of sowing

Treatment	Yield of bulb grade		
	Grade A (> 5.5 cm)	Grade B (4.5-5.5 cm)	Grade C (< 4.5 cm)
Dates of sowing (D) :			
D_1 : 18th August	83.9 (27.65)	192.1 (63.3)	34.0 (11.2)
D_2 : 28th August	84.2 (29.0)	200.0 (68.9)	24.9 (8.57)
D_3 : 7th September	72.5 (26.0)	180.6 (64.6)	26.5 (9.50)
D_4 : 17th September	48.7 (20.2)	158.0 (65.7)	25.5 (10.6)
S.Em. ±	4.1	6.8	1.9
C.D. at 5 %	12.1	19.8	5.0
Methods of sowing (S) :			
S_1 : Direct seeding	64.9 (24.20)	174.2 (65.0)	32.6 (12.0)
S_2 : Transplanting	79.9 (27.7)	191.0 (66.0)	22.8 (7.9)
S.Em. ±	2.9	4.8	1.2
C.D. at 5 %	8.5	14.4	3.5
C.V. %	16.1	10.5	17.2
Interaction :			
(D×S)	NS	NS	NS

Figures in parenthesis refer to per cent of bulb grade.

A Grade onion bulb yield (> 5.5 cm diameter)

Among different dates D_1 (18th Aug.), D_2 (28th Aug.) and D_3 (7th Sept.) remained at par in terms of production of A grade bulbs. The last date of sowing D_4 (17th Sept.) produced significantly the lowest yield of A grade bulbs.

B grade onion bulb (4.5 cm to 5.5 cm diameter)

Data presented in Table 14 indicated that the treatment D_1 (18th Aug.). D_2 (28th Aug.) and D_3 (7th Sept.) did not differ significantly from each other in terms of production of B grade bulbs. Last date of sowing D_4 (17th Sept.) produced significantly the lowest yield of B grade bulbs.

C grade onion bulb (< 4.5 cm diameter)

Data presented in Table 14 indicated that first date of sowing D_1 (18th Aug.) produced significantly the highest yield of C grade bulbs. The latter dates D_2 (28th Aug.), D_3 (7th Sept.) and D_4 (17th Sept.) remained at par in respect of producing C grade bulbs.

Effect of methods of sowing

The data presented in Table 14 indicated significant effect of methods of sowing on grades of bulbs.

A Grade onion bulb (> 5.5 cm diameter)

Significantly higher yield of A grade bulbs was found under treatment S_2 (transplanting) than S_1 (direct seeding).

B grade onion bulb (4.5 cm to 5.5 cm diameter)

Data presented in Table 14 indicated that treatment S_2 (transplanting) produced significantly higher yield of B grade bulbs than treatment S_1 (direct seeding).

C grade onion bulb (< 4.5 cm diameter)

Data presented in Table 14 revealed that significantly higher yield of C grade bulbs was observed in treatment S_1 (direct seeding) than S_2 (transplanting).

Effect of interaction

The interaction was not found significant incase of A grade, B grade and C grade bulbs.

4.4 BIOCHEMICAL STUDIES :

4.3.1 Total Soluble Solids (per cent)

The data pertaining to per cent total soluble solids as influenced by dates and methods of sowing are furnished in Table 15. The analysis of variance is given in Appendix-III.

Effect of dates of sowing

Perusal of data presented in Table 15 indicated that the dates of sowing did not exert significant effect on total soluble solids per cent.

Effect of methods of sowing

The data presented in Table 15 revealed that the total soluble solids per cent were not significantly influenced by methods of sowing.

Table 15 : Total soluble solids per cent of onion as influenced by dates and methods of sowing

Treatment	Total soluble solids per cent
Dates of sowing (D) :	
D_1 : 18th August	15.2
D_2 : 28th August	15.6
D_3 : 7th September	14.2
D_4 : 17th September	14.2
S.Em. ±	0.6
C.D. at 5 %	NS
Methods of sowing (S) :	
S_1 : Direct seeding	15.0
S_2 : Transplanting	14.7
S.Em. ±	0.4
C.D. at 5 %	NS
C.V. %	12.0
Interaction :	
(D × S)	NS

Table 16 : Effect of different treatments on gross and net realization

Treatment	Bulb yield (q ha^{-1})	Gross realization (Rs. ha^{-1})	Total cost of cultivation (Rs. ha^{-1})	Net realization (Rs. ha^{-1})	C.B.R.
Dates of sowing (D) :					
D_1 : 18th August	303.34	121336	30059	90977	1:4.0
D_2 : 28th August	290.29	116116	30059	86057	1:3.9
D_3 : 7th September	278.69	83607	30459	53148	1:2.8
D_4 : 17th September	240.58	72174	30459	41715	1:2.4
Methods of sowing (S) :					
S_1 : Direct seeding	268.40	80490	23368	57122	1:3.4
S_2 : Transplanting	288.40	115360	37147	78213	1:3.1

Note : The selling price of onion bulbs

D_1 : Rs.400 q^{-1}
D_2 : Rs.400 q^{-1}
D_3 : Rs.300 q^{-1}
D_4 : Rs.300 q^{-1}
S_1 : Rs.300 q^{-1}
S_2 : Rs.400 q^{-1}

Effect of interaction

The interaction failed to exert its significant influence on total soluble solids per cent of onion bulbs.

4.5 ECONOMICS :

The details of gross and net realization as well as cost of cultivation of onion as affected by different treatments are presented in Table 16. The total cost of production ha^{-1} is worked out for individual treatment combination and given in Appendix-IV.

Effect of dates of sowing

An examination of data given in Table 16 revealed that the maximum net realization of Rs. 90977 ha^{-1} was accrued when the onion crop was sown on 18th August. The lowest net realization of Rs.41715 ha^{-1} was obtained with last date of sowing (D_4).

Effect of methods of sowing

Data presented in Table 16 revealed that higher net realization of Rs.78213 ha^{-1} was obtained with the treatment S_2 (transplanting) as compared to Rs. 57122 ha^{-1} with direct seeding (S_1). The increase in net realization under transplanting method over direct seeding was Rs. 21091 ha^{-1}.

Data presented in Appendix-V indicated that transplanting of seedlings on 18th August (D_1S_2) realized maximum net profit of Rs. 91453 ha^{-1}.

DISCUSSION

V. DISCUSSION

A brief discussion of the results obtained from the present investigation entitled "Response of direct seeded and transplanted onion (*Allium cepa* L.) to dates of sowing in *kharif* season under North Gujarat condition" has been presented in this chapter. The variations observed in growth and yield attributes as well as yield and quality of onion under the influence of different treatments and their combinations are discussed here. It has been attempted to establish effect and cause relationship based on the results of the present study duly supported by available evidences and relevant literature.

5.1 EFFECT OF DATES OF SOWING :

Plant population

Initial and final plant population was not significantly influenced due to different dates of sowing. From the data presented in Table 6, is seen that the plant population in all the dates of sowing was found uniform.

Growth attributes

Different dates of sowing significantly influenced plant height at 60 DAS/DATP, 90 DAS/DATP and at harvest (Table 7). Early sowing on 18th August (D_1) produced the tallest plants measuring the plant height of 29.5, 66.4 and 58.7 cm at 60 DAS/DATP, 90 DAS/DATP and at harvest respectively. Decreasing trend in plant height was observed at 60 DAS/DATP and 90 DAS/DATP with successive delay in sowing after first date D_1 (18th Aug.). Thus, early sowing favoured for increasing plant height over delayed sowing. The number of leaves per plant (Table 8) and neck thickness

D_1S_1

D_2S_1

D_3S_1

D_4S_1

Plate : II Effect of dates of sowing on direct seeded onion crop

(Table 9) was also significantly influenced due to dates of sowing. Treatment D_1 (18th Aug.) recorded significantly the highest number of leaves *i.e.*, 5.9, 8.6 and 6.2 at 60 DAS/DATP, 90 DAS/DATP and at harvest respectively. The last date of sowing D_4 (17th Sept.) produced the lowest number of leaves *i.e.*, 4.8, 7.1 and 4.8 leaves per plant at 60 DAS/DATP and 90 DAS/DATP and at harvest respectively. Treatment D_1 (18th Aug.) recorded more neck thickness (0.71 cm) than treatment D_2 (28th Aug.) with 0.61 cm at harvest but both these treatments remained at par with each other in respect of neck thickness at 60 DAS/DATP and 90 DAS/DATP. Maximum number of leaves per plant and more neck thickness were registered with early sowing on 18th August (D_1), whereas delayed sowing on 17th September (D_4) produced lower number of leaves and less neck thickness. The first date of sowing (18th Aug.) remained at par with second date D_2 (28th Aug.) in case of neck thickness at 60 DAS/DATP and 90 DAS/DATP but it produced more neck thickness at harvest. Successive delay in sowing after first date D_1 (18th Aug.) tended to decrease the number of leaves per plant as well as neck thickness at 60 DAS/DATP, 90 DAS/DATP and at harvest. Favourable effect of early sowing on these attributes might be due to receipt of the rains after sowing and availability of lesser sunshine, as it had helped in better establishment of seedlings and better initial growth. Results of the present study are in conformity with the observations of Singh and Singh (1974), Moursi *et al.* (1975), Singh and Korla (1991), Singh *et al.* (1993) Kavani (1996), Movalia *et al.* (1999), Hiray (2001) and Rajeshkumar *et al.* (2003).

D_1S_2

D_2S_2

D_3S_2

D_4S_2

Plate III Effect of dates of sowing on transplanted onion crop

The dates of sowing exerted their significant effect on bolting per cent of onion (Table 10). The highest bolting per cent (41.2) were noticed with last date of sowing on 27th September (D_4). Among different dates of sowing, early sowing on 18th August (D_1) registered the lowest bolting per cent (22.8). Successive delay in sowing after 18th August (D_1) showed increasing trend in bolting per cent of onion. Prevalence of low temperature with short day length and long cool period during bulb growth and development might have favoured more bolting in delayed sown crop. These results are in agreement with the findings reported by Nagre *et al.* (1985). The data pertaining to jointed bulb per cent (Table 10) indicated that the dates of sowing did not express significant effect on jointed bulb per cent of onion. This might be due to conducive climatic conditions and suitability of variety. Similar results have been reported by Bhonde *et al.* (1990).

Days to maturity (Table 10) were significantly influenced by different dates of sowing. Early sowing on 18th August (D_1) significantly reduced maturity period (173 days) over later sowing dates D_2 (28th Aug.), D_3 (7th Sept.) and D_4 (17th Sept.). Though treatment D_4 took maximum number of days (182) to maturity of the crop, was found statistically at par with treatments D_2 (28th Aug.) and D_3 (7th Sept.). Receipt of the rains after sowing and lesser sunshine after first date of sowing D_1 (18th Aug.) might have helped in better establishment of the seedlings and better initial growth, which ultimately resulted in early maturity.

5.1.2 Yield and yield attributes

An examination of data presented in Table 11 revealed that different dates of sowing exhibited their significant influence on yield attributes such as diameter and weight of bulb. First date D_1 (18th Aug.) measured maximum diameter of bulb (5.78 cm) followed by D_2 (28th Aug.) with 5.37 cm. With regard to weight of bulb, early sowing (D_1) was found superior by producing a bulb of 76.2 g. The last date of sowing D_4 (17th Sept.) produced the bulb of the lowest weight (61.4 g.) and diameter (4.45 cm). Successive delay in sowing after first date (18th Aug.) tended to reduce the diameter as well as weight of the bulb. The magnitude of increase in diameter of bulb under treatment D_1 (18th August) was 7.64, 15.83 and 29.89 per cent and for weight of bulb was 9.80, 16.96 and 24.20 percent respectively over D_2 (28th August) D_3 (7th September) and D_4 (17th September) treatments. The improvement in diameter and weight of bulb per plant with early sowing on 18th August (D_1) might be due to favourable weather conditions during bulb development stage. The results are corroborated with the findings of Arora (1967), Singh *et al.* (1971), Pandey *et al.* (1990), Bhamburkar *et al.* (1993), Singh *et al.* (1993), Kavani (1996), Movalia *et al.* (1999), Hiray (2001), and Rajeshkumar *et al.* (2003).

The sowing dates exerted significant effect on bulb, straw and total yield (Table 12). Early sowing on 18th August (D_1) produced the highest yield of 303.34, 49.33 and 352.69 q ha^{-1} of bulb, straw and total yield, respectively. The magnitude of increase in onion bulb yield with D_1 (18th Aug.) was

.26.08 per cent over treatment D_4 (17^{th} September). The per cent decrease in bulb yield observed under D_2 (28^{th} Aug.), D_3 (7^{th} Sept.) and D_4 (17^{th} Sept.) was 4.29, 8.11 and 20.68 respectively over treatment D_1 (18^{th} Aug.). A similar trend in straw yield was also observed with different dates of sowing. Each date of sowing behaved differently on yield of onion. Gradual decrease in bulb, straw and total yield was observed when the sowing delayed after 18^{th} August (D_1). The maintenance of optimum plant population, and favourable weather conditions in early sown crop (D_1) might have helped to increase growth and yield attributes viz., plant height, number of leaves per plant, neck thickness of plant, diameter of bulb, weight of bulb and ultimately the bulb and straw yield. Similar results have been reported by Singh *et al.* (1971) Singh and Singh (1979), Singh *et al.* (1993), Amin *et al.* (1995), Kavani (1996), Movalia *et al.* (1999), Gupta *et al.* (1999), Hiray (2001) and Rajeshkumar *et al.* (2003).

The data regarding dry matter per cent and dry matter yield q ha^{-1} summarized in Table 13 indicated, significant influence of dates of sowing and the highest dry matter per cent (15.9) and dry matter yield (48.8 q ha^{-1}) was obtained with first date of sowing D_1 (18^{th} Aug.) followed by second date of sowing D_2 (28^{th} Aug.). Treatment D_3 (7^{th} Sept.) and D_4 (17^{th} Sept.) remained at par with each other in terms of dry matter per cent. The lowest dry matter yield of 31.7 q ha^{-1} was observed with last date of sowing (D_4) on 17^{th} September. This might probably be due to better growth and yield attributes obtained under treatment D_1 (18^{th} Aug.) and ultimately higher dry matter per cent and dry

matter yield. The results are in confirmity with the observations made by Verma *et al.* (1971), Singh and Singh (1974) and Moursi *et al.* (1975).

The dates of sowing significantly influenced the yield of different grades of bulb (Table 14). The highest yield of A and B grade bulbs were obtained with second date of sowing D_2 (28th Aug.). However, the highest yield of C Grade bulbs was observed in D_1 (18th Aug.). Treatment D_2 (28th Aug.) remained at par with D_1 (18th Aug.) and D_3 (7th Sept.) in terms of production of A and B Grade bulb yield.

5.1.3 Biochemical studies

Total soluble solids

Dates of sowing did not exert significant effect on total soluble solids per cent (Table 15). Similar results have been reported by Pandey *et al.* (1990) and Movalia *et al.* (1999).

5.2 EFFECT OF METHODS OF SOWING :

5.2.1 Plant population

The data on initial and final plant population as influenced by methods of sowing (Table 6) indicated that, treatment S_1 (direct seeding) registered higher plant stand than S_2 (transplanting). Thus, the plant population is directly reflected to the method used for sowing.

5.2.2 Growth attributes

An appraisal of data presented in Table 7, 8 and 9 revealed that methods of sowing had significant effect on plant height, number of leaves per plant and neck thickness of plant, respectively at 60 DAS/DATP, 90 DAS/DATP and at

harvest. Significantly higher values of plant height, number of leaves per plant and neck thickness of plant was observed in S_2 (transplanting) over S_1 (direct seeding). This might be due to receipt of optimum space by each plant and thereby efficient utilization of light, aeration, moisture and nutrients under transplanting. Kapadia (1996) and Movalia *et al.* (1999) also reported such beneficial effects of transplanting method in onion.

From the data on bolting per cent and jointed bulb per cent (Table 10) it appears that the methods of sowing did not express their influence on bolting per cent. Higher values of jointed bulb (5.6 %) were noticed with direct seeding (S_1) over transplanting (S_2). This might be due to over population and there by over competition for light, aeration, moisture and nutrients. The results are in close agreement with those reported by Movalia *et al.* (1999).

The onion maturity period was also significantly influenced due to methods of sowing (Table 10). In direct seeding (S_1) the onion matured late, took 190 days, where as transplanted crop (S_2) required 166 days. The reason for the late maturity of onion bulb in direct seeding can be attributed to additional time taken from germination to seedling stage and over population. In transplanting method (S_2), maturity of the bulbs was computed from the date of transplanting. Similar results have been reported by Khokhar *et al.* (1990).

5.2.2 Yield and yield attributes

The yield attributes *viz.*, diameter and weight of onion bulb were significantly affected by methods of sowing (Table 11). Higher values for both these parameters were recorded under treatment S_2 (transplanting) over that of

direct seeding (S_1). The magnitude of increase in diameter of bulb under transplanting was 21.29 per cent and that of weight of bulb was 36.67 per cent over direct seeding (S_1) at harvest. This might have resulted due to maintenance of optimum plant population and spacing under transplanting method (S_2). which might have helped for more vegetative growth and bulb development and ultimately an increase in diameter and weight of bulb of onion. These results are in line with those reported by Khokhar *et al.* (1990), Kapadia (1996), Movalia *et al.* (1999) and Sukhadia *et al.* (2001).

The yield of onion bulb, straw and total yield (Table 12) was significantly influenced by methods sowing. Transplanting (S_2) was found better than direct seeding (S_1) producing 7.57, 9.73 and 7.88 per cent higher bulb, straw and total yield respectively. The maintenance of optimum plant population and spacing under S_2 (transplanting) might have helped to improve growth and yield attributes *viz.*, plant height, number of leaves per plant, neck thickness of plant, diameter and weight of bulb and ultimately the onion bulb yield. This finding akin the report of Kakehi (1958), Khokhar *et al.* (1990), Warid and Loaiza (1993), Kapadia (1996), Movalia *et al.*(1999) and Sukhadia *et al.*(2002) in dry onion bulb.

The data regarding dry matter per cent and dry matter yield q ha^{-1} presented in Table 13 indicated that the dry matter per cent was not significantly influenced by methods of sowing while dry matter yield was significantly higher with S_2 (transplanting) than S_1 (direct seeding). This might be due to better vegetative growth observed under transplanting of seedlings,

and thereby dry matter yield. The results are in conformity with the observations made by Moursi *et al.* (1975).

The yield of A Grade, B Grade and C Grade bulbs (Table 14) were significantly influenced by the methods of sowing and higher values of A Grade and B Grade bulbs were recorded under S_2 (transplanting) than S_1 (direct seeding). While higher values of C Grade bulb yield were observed under S_1 (direct seeding) than S_2 (transplanting).

5.2.3 Biochemical studies

Total soluble solids

Methods of sowing did not express their significant effect on total soluble solids (Table 15) and it might be due to marginal variations in the weather during bulbing period. The results are supported by those of Movalia *et al.* (1999).

SUMMARY & CONCLUSION

VI. SUMMARY AND CONCLUSION

An experiment was conducted on loamy sand soil of Agronomy Instructional Farm, C. P. College of Agriculture, Sardarkrushinagar to study the "Response of direct seeded and transplanted onion (*Allium cepa* L.) to dates of sowing in *kharif* season under North Gujarat condition" during 2003-04. Eight treatment combinations comprising four dates of sowing *viz.*, D_1 (18^{th} Aug.), D_2 (28^{th} Aug.), D_3 (7^{th} Sept.) and D_4 (17^{th} Sept.) as main plot treatments and two methods of sowing *viz.*, S_1 (direct seeding) and S_2 (transplanting) as sub-plot treatments were tested in the factorial randomized block design with four replications. The onion variety selected for *kharif* season was Agri-found Dark Red. The main objective of the study was to find out appropriate time and method of sowing for *kharif* onion under North Gujarat condition.

The results presented and discussed in the preceding chapters are summarized here.

6.1 EFFECT OF DATES OF SOWING :

[1] Initial and final plant population was not significantly influenced by dates of sowing.

[2] The dates of sowing exerted their significant influence on plant height, number of leaves per plant, neck thickness, bolting per cent, maturity days, diameter and weight of bulb, yield (bulb, straw and total), dry matter per cent, dry matter yield and yield of A, B and C grade bulbs.

[3] Among the dates, D_1 (18th Aug.) found superior by recording higher values of plant height, number of leaves and neck thickness at 60 DAS/DATP, 90 DAS/DATP and at harvest. Similarly early sowing on 18th August (D_1) helped to reduce bolting per cent over delayed sowing in September (D_3 and D_4)

[4] Treatment D_1 (18th Aug.) took significantly lower number of days for maturity of onion as compared to delayed sowing (D_2, D_3 and D_4)

[5] Higher values of diameter and weight of bulb were recorded under first date of sowing (D_1) as compared to later dates of sowing (D_2, D_3 and D_4).

[6] The onion bulb, straw and total yields were significantly influenced by dates of sowing. The maximum bulb, straw and total yields were recorded under treatment D_1 (18th Aug.). The lowest yield of bulb, straw and total yields were observed under fourth date D_4 (17th Sep.).

[7] Significantly the highest dry matter per cent and dry matter yield were recorded with early sowing on 18th August (D_1).

[8] The highest yield of C Grade bulb was observed under treatment D_1 (18th Aug.) whereas D_2 (28th Aug.) recorded maximum yield of A and B grade bulbs.

[9] Total Soluble Solids per cent were not significantly influenced by dates of sowing.

[10] The maximum net profit of Rs.90977 ha^{-1} was obtained with early sowing on 18th August (D_1).

6.2 EFFECT OF METHODS OF SOWING :

[1] Initial and final plant population was significantly influenced by the methods of sowing and the values were higher with direct seeding (S_1) than transplanting (S_2).

[2] Methods of sowing expressed their significant influence on plant height, number of leaves per plant, neck thickness, jointed bulb per cent, maturity days, diameter and weight of bulb, yield (bulb, straw and total), dry matter yield and yield of bulb grades. Plant height, number of leaves per plant and neck thickness of plant at 60 DAS/DATP, 90 DAS/DATP and at harvest was significantly increased with transplanting (S_2) over direct seeding (S_1).

[3] Significantly higher Jointed bulb per cent was observed under direct seeding (S_1) as compared to transplanting (S_2). Bolting per cent in onion was not influenced by methods of sowing.

[4] Direct seeding (S_1) required significantly longer period for maturity than transplanting (S_2).

[5] Higher values of diameter and weight of onion bulb were found with transplanting (S_2) over direct seeding (S_1).

[6] Between the methods, transplanting (S_2) produced significantly higher bulb, straw and total yield over direct seeding (S_1).

[7] Dry matter per cent was not significantly influenced by methods of sowing. Higher dry matter yield was recorded under transplanting (S_2) over direct seeding (S_1).

[8] Higher yield of A and B Grade bulbs was recorded under transplanting (S_2) where as direct seeding (S_1) produced higher yield of C grade bulbs.

[9] Total soluble solids per cent was not significantly influenced by the methods of sowing.

[10] The maximum net profit of Rs.78213 ha^{-1} was obtained under transplanting (S_2).

CONCLUSION :

The results of present investigation indicated that to secure maximum yield and net profit from *kharif* onion the crop should be sown on 18th August by transplanting the seedlings.

FUTURE LINE OF WORK :

[1] To have valid conclusion, the present study should be repeated at least one more year.

[2] There is a need to identify short duration *kharif* onion suitable to semi-arid region.

[3] Economic feasibility of sprinkler/drip irrigation needs to be investigated.

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* **Original are not seen.**

APPENDICES

ndix I : Analysis of variance for plant population, plant height, number of leaves and neck thickness

Mean sum of square (MSS)

rce f ance	Initial plant population	Final plant population	df	Plant height (cm)			Number of leaves			Neck thickness (cm)		
				60 DAS/DATP	90 DAS/DATP	At harvest	60 DAS/DATP	90 DAS/DATP	At harvest	60 DAS/DATP	90 DAS/DATP	At harvest
ation	360.0	420.9	3	0.11	13.36	13.67	0.15	0.44	0.13	0.001	0.031	0.004
of g	237.5	159.9	3	61.68*	167.22*	217.68*	1.69*	3.91*	3.27*	0.02*	0.094*	0.085*
ds of g	336.9*	343.7*	1	212.43*	199.46*	235.45*	4.07*	2.89*	3.79*	0.32*	0.15*	0.13*
	596.2	586.6	3	4.05	17.02	30.69	0.11	0.58	0.24	0.002	0.007	0.001
	392.8	373.3	21	4.75	13.56	12.15	0.16	0.33	0.30	0.002	0.005	0.002

ificant at 5 per cent level.

ndix II : Analysis of variance for bolting per cent, jointed bulb per cent and days taken for maturity

Mean sum of square (MSS)

e of variance	Bolting per cent	Jointed bulb per cent	Maturity Days
	At harvest	At harvest	
cation	27.144	3.365	2.71
of sowing	502.063*	2.1198	130.46*
ods of sowing	10.847	30.031*	4324.50*
	28.284	0.448	10.17
	31.013	0.912	3.399

ificant at 5 per cent level.

Appendix III : Analysis of variance for yield , yield attributes and total soluble solids

Mean sum of square (MSS)

	df	Diameter of bulb (cm)	Weight of bulb (g)	Bulb yield (q ha^{-1})	Straw yield (q ha^{-1})	Total yield (q ha^{-1})	Dry matter per cent	Dry matter yield (q ha^{-1})	Bulb grade (q ha^{-1})			Total Soluble Solids per cent
									A grade	B grade	C grade	
Replication	3	0.261	55.063	27.46	1.33	38.41	0.540	4.18	44.8	64.4	8.8	11.5
Dates of sowing	3	2.58*	324.12*	5850.35*	587.60*	10138.34*	12.68*	399.91*	2220.1*	793.5*	142.2*	3.8
Methods of sowing	1	7.86*	3553.25*	3310.95*	121.30*	4699.66*	3.82	200.41*	1807.5*	2251.3*	776.2*	0.7
D × S	3	0.42	30.70	232.21	7.70	304.54	0.63	25.69	74.6	25.1	56.2	1.2
Error	21	0.18	37.08	99.36	10.64	159.67	0.94	11.89	134.9	768.9	22.8	3.2

* Significant at 5 per cent level.

Appendix IV : Total cost of cultivation of bulb onion (Rs. ha^{-1}) as affected by different treatment combinations

Treatment combination	Cost of land preparation Rs. ha^{-1}	cost of fertilizer with application Rs. ha^{-1}	Cost of seed with sowing Rs.ha^{-1}	Cost of nursery raising including transplanting Rs. ha^{-1}	Irrigation cost Rs. ha^{-1}	Hand weeding cost Rs. ha^{-1}	Harvesting cost Rs.ha^{-1}	Plant protection cost Rs. ha^{-1}	Gap filling cost Rs. ha^{-1}	Total cost of cultivation Rs. ha^{-1}
D_1S_1	1013	2263	2050	-	8800	2030	6167	845	-	23,168
D_1S_2	1013	2263	-	17063	8000	1500	6167	416	525	36,947
D_2S_1	1013	2263	2050	-	8800	2030	6167	845	-	23,168
D_2S_2	1013	2263	-	17063	8000	1500	6167	416	525	36,947
D_3S_1	1013	2263	2050	-	9200	2030	6167	845	-	23,568
D_3S_2	1013	2263	-	17063	8400	1500	6167	416	525	37,347
D_4S_1	1013	2263	2050	-	9200	2030	6167	845	-	23,568
D_4S_2	1013	2263	-	17063	8400	1500	6167	416	525	37,347

Price of Urea	4.80 Rs. kg^{-1}
DAP	8.89 Rs. kg^{-1}
Muriate of potash	5.50 Rs. kg^{-1}
Seed	170 Rs. kg^{-1}
Irrigation including application	400 Rs. ha^{-1}
Man and women labour	50 Rs. day^{-1}

Appendix V : Economics of different treatment combinations

Sr. No.	Treatment combination	Bulb yield (q ha^{-1})	Gross realization (Rs. ha^{-1})	Cost of cultivation (Rs. ha^{-1})	Net Realization (Rs. ha^{-1})	Cost Benefit Ratio
1.	D_1S_1	285.7	1,14,280	23,168	91,112	1: 4.9
2.	D_1S_2	321.0	1,28,400	36,947	91,453	1: 3.5
3.	D_2S_1	280.1	1,12,040	23,168	88,872	1: 4.3
4.	D_2S_2	300.4	1,20,160	36,947	83,213	1: 3.3
5.	D_3S_1	273.4	82,020	23,568	58,452	1: 3.5
6.	D_3S_2	284.0	85,200	37,347	47,853	1: 2.3
7.	D_4S_1	233.0	69,900	23,568	46,332	1: 3.0
8.	D_4S_2	248.2	74,460	37,347	37,113	1: 2.0

Note :

The selling price of onion bulbs

D_1S_1 @ Rs. 400 q^{-1}
D_1S_2 @ Rs. 400 q^{-1}
D_2S_1 @ Rs. 400 q^{-1}
D_2S_2 @ Rs. 400 q^{-1}
D_3S_1 @ Rs. 300 q^{-1}
D_3S_2 @ Rs. 300 q^{-1}
D_4S_1 @ Rs. 300 q^{-1}
D_4S_2 @ Rs 300 q^{-1}

CERTIFICATE

This is to certify that, I have no objection for supplying to any scientist only one copy of any part of this thesis at a time through reprographic process, if necessary for rendering reference service in a library or documentation center.

Vaghela

Place : Sardarkrushinagar
Date : 25th February, 2005

(S. J. VAGHELA)