EFFECT OF DATES OF SOWING AND STAGES OF HARVESTING ON FORAGE YIELD AND QUALITY OF MAIZE (*ZEA MAYS* L.) VARIETIES

A

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ABSTRACT

"EFFECT OF DATES OF SOWING AND STAGES OF HARVESTING ON FORAGE YIELD AND QUALITY OF MAIZE VARIETIES" (ZEA MAYS L.)

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ABSTRACT

The investigation was carried out at the Forage Research Project Farm, Gujarat Agricultural Universtiy, Anand during the year 1999, to assess the "Effect of dates of sowing and stages of harvesting on forage yield and quality of maize varieties". The experiment was laid out in Split Plot Design with three replications. The treatment comprised of three dates of sowing (30th June, 15th July, and 30th July), three harvesting stages (Tasseling, Silking and Milking stages) and two varieties (African Tall, Gujarat Maize-2).

The study revealed that the sowing of maize crop on 30th June (D_1) recorded significantly higher leaf length, leaf width, total number leaves and stem thickness. The highest GFY, DMY, CPY,

NDF, IVDMD and DDM were also obtained when maize crop was sown on 30th June.

The harvesting of maize crop at silking stage (T_3) recorded significantly high leaf length, leaf width, number of leaves and stem thickness. The highest GFY, DMY, CPY, INDF and DDM were also obtained when crop was harvested at milking stage but harvesting at tasseling stage gave significantly higher CP and IVDMD contents.

Among two varieties, variety African Tall (V_2) produced significantly higher total number of leaves, leaf length, leaf width and stem thickness. The highest GFY, DMY, CPY and DDM production as well as DM content were also obtained with variety African Tall, but variety Gujarat Maize-2 synthesized significantly higher CP and IVDMD contents.

From the results of the investigation it could be inferred that sowing of maize crop on 30th June using variety African Tall and harvesting it at milking stage was most effective in obtaining the higher green forage, dry matter as well as crude protein yield , which is also superior in quality.

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CERTIFICATE

This is to certify that the thesis entitled "**Effect of dates of Sowing and stages of harvesting on forage yield and quality of maize (Zea mays L.) varieties**" submitted by "**Shri Vinay Gour**" in partial fulfillment of the requirements for the degree of "**Master of Science (Agriculture)**" in "**Agronomy**" of the Gujarat Agricultural University is a record of bonafide research work carried out by him under my guidance and supervision and the thesis has not previously formed the basis for the award of any degree, diploma or other similar title.

Anand

Date: 18- 9 -2000

(T D PATEL)

Major Advisor

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INTRODUCTION

1. INTRODUCTION

India ranks first among major livestock holding countries in the world. It has about 15 per cent of the world bovine population but the milk production in the country is only about 3.2 per cent (Singhal, 1995). As far as milk production is concerned, it is estimated that the milk production can be easily increased by 20-30 per cent by adequate supply of nutritious feeds and fodders. The fodder production in the country is not sufficient to meet the requirement of livestock population and also the forages so produced are poor in quality. Our dry and green fodder availability is only 890 and 1064 million tonnes, against our requirement on dry weight basis is 1056 million tonnes (Hazra, 1995). In recent years, India is facing an acute shortage of feeds and fodders.

In Gujarat, the total animal population of 19.76 million heads requires about 49.2 million tonnes of fodder but only 20 million tonnes is made available in normal years. The animals are chiefly fed on poor quality roughages. Thus, the state is not only in short of quantity but quality fodder also. Therefore, it is very essential to bridge the gap between demand and supply

so as to meet the minimum requirement of livestock. The green forage is the cheapest source of feed for milch, beef and drought animals. Therefore, development of fodder resources of the country has become a high priority in national programme. This could be achieved through bringing more area under fodder cultivation and increasing productivity of fodder crops per unit area and time. At present only 4.4 per cent (8.23m ha) of the country's cropped area is under fodder crops (Singh, 1993) while in Gujarat, it accounts 1.207 m ha of the gross cropped area (Patel et al., 1999).

Maize (*Zea mays* L.) is one of the most important dual purpose crop grown for grain as well as fodder in India. It is almost ideal cereal forage crop because of its quick-growing nature, high-yield and palatable nutritious quality. Its wider adaptability over a range of environmental conditions and cropping season signifies as good forage crop. It can be safely fed at any stage of crop growth. It is widely cultivated as *Kharif* crop in India. It gives almost uniform green forage yield throughout the year. Being a C_4 in nature, this crop is highly adaptable to subtropical climate and can thus thrive well even at high temperature.

In India, maize ranks fifth in area, third in production and productivity among cereal crops. The important maize growing states in India are Punjab, Haryana, Uttar Pradesh, Madhya Pradesh, Bihar, Maharashtra, Rajasthan, Gujarat, Andhra Pradesh, Tamil Nadu and Jammu Kashmir. The area under maize crop in Gujarat is about 0.372 m ha, whereas on all India basis it is about 6.011 m ha (Anonymous, 1995).

The optimum time of sowing ensures better harmony between the plant and the weather. Early as well as delayed sowing in *Kharif* causes severe problems of insects and pests, birds and moisture stress at critical stages of crop growth. Therefore, assessment of proper date of sowing will not only help in balanced development during vegetative and reproductive phases of various groups of maize cultivars but also help in improving the productivity of crop may be either grain or forage. The time of sowing decides the duration of phenological stages and morphological development occurring in plants resulting in fodder and grain yield.

Estimating the chemical composition and nutritive value of fodder crops at different stages of growth will have practical importance, as the proper stage at which the fodder crop

have to be cut for feeding the animal can be evaluated to obtain maximum nutrients.

The choice of crop variety depends on the length of growing period available with regard to rainfall and favourable temperature for crop growth and development. In region where length of growing period is longer, early sown and long duration varieties perform better while for shorter growing period short duration and late sown varieties proved better. Thus, identification of appropriate genotype will help to increase and stabilize the yield of maize under varying lengths of growing period.

The maize variety African Tall has been found promising throughout country, which takes longer period for maturity (90 days). The maize variety Gujarat Maize-2 released by the Gujarat Agricultural University, requires shorter period (70 days) for forage production. Hence, it was thought worthwhile to compare these varieties under different date of sowing and harvesting stages during *kharif* season under Middle Gujarat Agro-climatic Zone-III.

With this background a field trial was undertaken to study the "EFFECT OF DATES OF SOWING AND STAGES OF

HARVESTING ON FORAGE YIELD AND QUALITY OF MAIZE VARIETIES" at the Forage Research Project Farm, Gujarat Agricultural University, Anand during *Kharif* 1999 with the following objectives.

1. To find out appropriate date of sowing to obtain maximum forage yield with better nutritive value.
2. To find out superior variety for forage yield and quality.
3. To find out optimum stage of harvesting for higher forage yield and better quality of forage.
4. To find out the best combination of date of sowing, variety and harvesting stage for obtaining maximum yield and better quality of forage maize.

REVIEW

2. REVIEW OF LITERATURE

In India summer crop of maize is usually grown from March while *kharif* crop with irrigation facility can be sown at any time from the beginning of May to July. Right maturity group cultivar, proper time of sowing and proper harvesting stage has been a priority consideration in fodder maize production aimed to obtaining higher forage yield with better nutritive value.

2.1 EFFECT OF SOWING DATES

2.1.1 On Growth Characters

- The research work carried out at Tanganyika reported that maize crop sown on 28th December produced higher yield, but when it sown later than December, total plant weight reduced upto 50% (Anonymous, 1959).
- Relwani (1962) working at Punjab Agricultural University, Ludhiana concluded that maize crop sown earlier on 15th June suffers in growth due to unfavourable hot and dry weather conditions. Late sown crop (30th July) on the other hand being spoiled by heavy showers or rain occurring immediately after

sowing. Sowing on 1st July was found superior and gave maximum yield.

- Lutrick, 1969 at Western Florida reported that when maize crop was sown after June, the cob length and lodging susceptibility increased.
- Urano *et al.*, (1965) at Japan observed that vegetative growth of early maturing variety was favoured by later sowing, while that of late maturing varieties falls progressively with delayed sowing.
- In field trial at Agraria with different sowing dates of maize (First, third week of May and first week of June), the LAI with third week of May was the greatest and least with first week of May sown (Lourence and Coroleno, 1990).
- Elsher *et al.*, (1991) at Cairo, Egypt observed progressive decrease in LAI and biomass when maize crop was sown after May.
- Singh *et al.*, (1992) at I.G.K.V.V., Ambikapur, Madhya Pradesh revealed that sowing of maize after 27th June resulted in weaker plant growth and shorter plant height.
- Mittal *et al.* (1999) at Rajasthan college of Agriculture, Udaipur, Rajasthan observed that maize crop sown on 27th June recorded

significantly higher plant height and LAI as compared to late sown crop (10th July and 21st July).

2.1.2 On Phenology

- Zuber (1966) at South Dakota, USA found that a 20 days delay in planting from April 20th to May 10th resulted in delay in silking (9.4 to 11.4 days) but a 20 days delay in planting from June 1st to June 20th resulted in delay of only 5 to 5.7 days in silking.
- Stauber *et al.* (1968) at Western Florida observed that the days to tasseling reduced by approximately one day with every 5-day delay in sowing. The reduction was more in case of mid duration cultivar than that of the short duration cultivar.
- Iwata and Okubo (1969, 1970) Japan reported that heat sum values in terms of effective degree required from sowing to silking and from silking to milking were constant regardless of time of sowing.
- Mecronic (1977) at Hamilton, New Zealand revealed that delayed sowing of maize from October to mid November decreased days to mid silk and increased days from mid silk to maturity.

- Bombay (1990) at Ukrainian, SSR reported field emergence of maize was faster with later sowing and percentage emergence also improved.
- Haung *et al.* (1990) at college of Agriculture, National University, Taiwan concluded that tasseling and silking hastened with the delayed sowing after May.
- Singh et al. (1990) at H.A.U., Hissar reported reduction in days to tasseling, silking and maturity when maize crop was sown after 12th December.
- Mittal *et al.* (1999) at R.C.A., Udaipur found that early planted crop (June 20th and July 10th) took about 4.5 days more than that of late planted crop (July 21st) for physiological maturity.

2.1.3 Effect On Yield And Yield Attributes

- Rai (1965) at Sudan concluded that the yield of maize crop decreased when it was delayed in sowing from July to August.
- Pathak *et al.* (1971) at Government Agricultural college, Kanpur reported that maize crop sown on 15th June produced higher yield as compared to sown on 1st July and 15th July.

- When the sowing was delayed to 25th June, the plant height and grain weight (Test weight) were increased while leaf number of maize was decreased (Shah, 1973).
- Farrell (1975) at New Zealand observed that in all the three experiments with sowing dates from 8th May to 26th June, resulted in increased leaf number with middle sowing date (10th June).
- Johnson (1981) at Illinois University, USA observed that grain yield of maize was the greatest when crop was sown in the 1st week of May.
- Taneja *et al.* (1984) at Hissar reported that maize crop sown on 10th April recorded significantly higher green forage as well as dry matter yield than the later sowings (25th April and 10th May) which were being at par with each other.
- Simmons and Jones (1985) at University of Minnesota, St. Poul, MN found in a field trial that maize crop gave maximum grain yield with early sowing in May. Further it was observed that on delayed sowing both grain yield and contribution of presilking assimilated tended to be lower.

- Kim-DA *et al.* 1988 at Korea reported that average dry mater yield of maize varieties planted on April 20th was significantly higher as compared to sown on 30th April and 13th May.
- Similarly, Kolcar and Videnovic (1988) reported maximum plant height, grain weight and higher yield of maize was obtained with early sowing (May) and decreased with later sowing.
- Nissen *et al.* (1988) at Valdria, Chile reported that plant and ear height, number of leaves per plant and internode were reduced by late sowing.
- Prasad and Joshi (1988) at the Vivekananda Parvatiya Krishi Anusandhan Shala, Almora reported that maize crop sown on 5th June recorded maximum plant height, stem thickness and higher grain and straw yield as compared to delayed sowing.
- Bali (1991) at Sher-e-Kashmir University of Agriculture Sciences and Technology, Shalimar Jammu and Kashmir, reported that maize crop sown on 15th May produced higher forage yield as compared to delayed sowing. (30th May, 15th June and 30th June).
- Graybill *et al.* (1991) at Cornell University, Ithaca, USA that maize crop sown on 25th April gave significantly higher yield as

compared to earlier or later sowings (24th March, 5 & 15th April and 5 & 15th May).

- Sundhu and Hundal (1991) at P.A.U., Ludhiana reported reduction in yield of maize associated with lower test weight due to late sowing after 1st week of November.
- Singh *et al.* (1992) at JNKVK, Ambikapur, Madhya Pradesh concluded that maize crop sown on 27th June produced significantly higher grain and straw yield than the crop sown on 11th July, 18th July and 25th July, but yield was comparable when sown on 4th July.
- Rosenzweig *et al* (1993) at Univ. of Oxford, USA reported that reduction in modeled maize yield was primarily attributed to temperature increase that shorten the crop growth period, particularly the grain filling period.
- Solaippan and Subramanian (1995) at T.N.A.U., Tamilnadu observed that sowing of maize crop on 15th September recorded an increase of 13.4 per cent in yield over sowing on 13th October.
- Mittal *et al.* (1999) at R.C.A., Udaipur concluded that maize crop sown on 29th June recorded significantly higher plant height, dry

matter accumulation, grain and stover yield over later sowing (10th and 21st July).

2.1.4 Effect On Nutrient Uptake

- Rai (1965) at Sudan revealed that nitrogen content in maize crop increased when sowing delayed from July to August.
- Similarly (1977) at Prince Edward Island, Canada also observed that plant nutrient level increased under the late sown condition.
- Kim-DA *et al.* (1988) at Korean reported that CP content and IVDMD content of maize varieties were not consistent with planting date, but NDF contents of early maturing varieties was slightly higher than that of late maturing maize varieties.
- While Olness *et al.*, (1990) reported that as sowing delayed, the time to reach maximum nitrogen accumulation decreased.
- Mittal *et al.* (1999) at R.C.A., Udaipur observed that uptake of N, P and K was increased with the earlier sowing date (29th June) followed by 10th July and 21st July sown crop.

2.2 EFFECT OF HARVESTING STAGE

2.2.1 On Yield And Yield Attributes

- Bryant *et al.* (1966) at Pennsylvania State University (USA) find out that higher dry matter yield of maize was observed when grain was at milk stage as compared to early stages.
- Worker and Marble (1968) at Pennsylvania State University, U.S.A revealed that dry matter yield generally increased as harvesting was delayed upto soft dough stage in sorghum as compared to early stages.
- Chauhan *et al.* (1979) reported that highest green and dry fodder yield of maize was obtained when the crop was harvested at milk stage.
- While studying the effect of harvesting stage on fresh matter yield of hybrid maize at Panceva (Yugoslavia), Lapceric (1979) reported that milk ripe stage was found optimum for harvesting higher fresh matter yield of maize.
- From the study taken at T.N.A.U., Coimbatore, Suresh Kumar *et al.* (1979) found that increased green and dry fodder yield of maize with delayed harvesting upto 70 DAS.

- In an experiment conducted at Pennsylvania State University (USA) during summer season, Desai and Washko (1982) observed increase in dry matter yield of fodder maize from boot stage (5.81 t/ha) to mature stage (8.9 t/ha).
- Tiwana *et al.* (1983) conducted a field trial at P.A.U., Ludhiana during summer, 1976 and *Kharif*, 1977 season. The results showed that the maximum green and dry fodder yield were recorded when maize crop was harvested at milk stage over tasseling and silking stage.
- Sawant and khanvilkar (1987) at Maharashtra concluded that green forage yield of maize was statistically being at par at tasseling, silking and milking stage. However, the silking stage was numerically superior. Similarly, harvesting of maize for fodder purpose at silking stage was found best at ICAR, New Delhi.(Anonymous, 1980).
- Patel *et al.*, (1990) conducted a field trial at Forage Research Project Farm, GAU, Anand and they observed that the harvesting of maize crop at milking stage gave 38.5 and 24.8 per cent higher dry matter yield over tasseling and silking stages, respectively during *Kharif* season.

- Paradkur *et al.* (1993) at Chhindwara (M.P) reported that higher monetory return was obtained from inter crop where the fodder maize was cut at tasseling stage as compared to later stage during *Kharif* season.
- Agath *et al.* (1997) at Junagadh, Gujarat reported that milking stage produced significantly higher green and dry fodder yield of maize than that of silking stage. The corresponding increase in green and dry fodder yield to the tune of 13.9 per cent and 22.8 per cent respectively, over silking stage.

From the above reviews we can conclude that milking stage is the appropriate stage for obtaining higher green forage as well dry matter yield.

2.2.2 Effect Of Harvesting Stage On Quality Of Fodder Maize

- Bryant *et al.* (1966) at Pennsylvaina State University (USA) concluded that crude protein and crude fibre contents were significantly lower and nitrogen free extract was significantly higher for the silage harvested at the mature stage as compared to the immature stage.

- Worker and Marble (1968) at Pennsylvania State University, USA revealed that per cent ash, crude protein content and fat content decreased in sorghum when harvesting was delayed (After soft dough stage).
- Tkachenko and Kogut (1975) at Ukraine, USSR reported maize harvesting at milk to wax, wax and full ripeness stage gave yields of 352, 354 and 348Kg protein, respectively.
- Mannikar *et al.*, (1976) carried out an experiment at I.G.F.R.I., Jhansi (U.P) during *kharif* revealed that crude protein content decreased with the age of plant, however, crude fibre per cent increased with advance maturity in fodder sorghum.
- Chauhan *et al.* (1979) reported that crude protein, digestible crude protein and total digestible nutrient yield of maize were higher when crop was harvested at milking stage during *kharif* season.
- The finding of Suresh kumar *et al.*, (1979) at Coimbatore observed that crude protein content of fodder maize decreased with the age of the crop. However, crude protein and crude fibre yield increased with advance of maturity.
- Sangha *et al.* (1980) while working at P.A.U, Ludhiana observed that decreased in crude protein, Ca and P content of maize with

delaying in harvesting from pre-bloom to dough stage during summer season.

- Telyatnikav *et al.*, (1980) at Russia find out that nutritive value of the silage was highest when maize plants were harvested at ware-ripe stage, but in dry year, early harvesting was recommended.
- Desai and Washko (1982) conducted a trial at Pennsylvania State University (USA). The results indicated that the per cent of crude protein, neutral detergent fibre and ash content of maize crop decreased with delaying in harvesting from boot stage to maturity.
- Tiwana *et al.* (1983) while working at P.A.U. Ludhiana, found that the crude protein content in fodder maize decreased with age of plant. However, they recorded the highest crude protein yield (14.39 q/ha) when mixture of maize and cowpea fodders were harvested at milking stage and the lowest (8.09 q/ha) at tasseling stage.
- The results of an experiment conducted by Patel *et al.* (1990) at GAU Anand revealed that the milk stage produced 14.8 and 23.9 per cent higher crude protein yield of maize than that of tasseling and silking stages respectively during *kharif* season.

- Firdous *et al.* (1996) at Pakistan reported that digestibility of maize fodder was affected by the stage of maturity and cultivar type, maturity had a greater effect on digestibility in all plant fractions than did cultivars and *in vitro* dry matter digestibility decreased with advance in maturity.
- Agath *et al.* (1997) at Junagadh, Gujarat reported that crude protein content of maize was significantly higher while crude fibre content was significantly lower in the forage cut at the silking than the milking stage.
- Tolera *et al.* (1998) at Awassa, Ethiopia concluded that maize stover harvested at early stage had higher ash content and CP content whereas NDF and cellulose contents were higher when harvested at later stage.

2.3 EFFECT OF VARIETIES

2.3.1 On Growth Characters

- Urano *et al.* (1965) reported that higher vegetative growth of maize obtained by early variety than the late variety under late sown condition.

- Krishnamurthy *et al.*(1973) concluded that dry matter and growth of maize differ significantly due to different varieties.
- Whereas, Pal and Panwar (1975) revealed that maize hybrid variety had shorter plant height than local varieties.
- The research work of I.A.R.I., New Delhi indicated that maize variety Vijay composite recorded higher leaf area as compared to hybrid Ganga-Safed (Anonymous, 1981).
- The research work of I.A.R.I., New Delhi showed that maize cultivar C-32 and Sartag have significantly higher plant height over C-33 and J-3022 (Anonymous, 1989).
- Further reported that Navjot cultivar of maize showed significantly higher plant height over kiran at Ludhiana (Anonymous, 1989).
- Endres and Mudstock (1989) reported that L.A.I and number of leaves per plant of maize were lower with medium maturity cultivar than late maturity cultivar.
- Lourenco and Caroleno (1990) at Agararia revealed that in general plant height and L.A.I of maize were greater in cultivar with and longer growth period than shorter growth period.

- Patil (1992) at Maharashtra reported that maize cv. African Tall recorded higher plant height and L.A.I than out yielding cv. Ganga Safed-2 and Ganga Safed-5.
- Judhao *et al.*, (1995) at Akola, Maharashtra observed higher plant height and number of leaves in African Tall as compared to Manjri composite.
- Mittal *et al.*, (1999) at R.C. A, Udaipur compared three maize varieties viz., Mahi Dhaval, Navjot and Mahi Kanchan and they revealed that Mahi Dhaval recorded significantly taller plant height over rest of the two varieties.

2.3.2 On Phenology

- Sirohi *et al.*, (1966) at I.A.R.I., New Delhi reported that long day length increased the days to tasseling, silking and maturity with late cultivar while that with early cultivar decreased.
- Stauber *et al.*, (1968) concluded that days to tasseling were more with medium maturity cultivar due to delayed sowing.
- Mittal et al., (1990) of Udaipur find out that variety Mahi Dhaval took maximum days for all phonological stages and for maturity (95 days) over Navjot (90 days) and Mahi Kanchan (81 days).

2.3.3 Yield And Yield Attributes

- Urano et al. (1965) observed that grain yield was higher with early cultivar than late cultivar when the crop was sown under late condition.
- Prasad and Singh (1988) reported while working with 8 cultivars that Vijay and Ganga Safed-2 produced higher yield.
- Among various germ plasm tested at Udaipur, D-765 and D-787 recorded higher maize grain yield (17.5q/ha) and stover yield (38.6 q/ha), closely followed by D-823 with 16.5 q/ha grain and 36.2 q/ha stover yield (Anonymous., 1988).
- Podolak and Horvath (1988) reported that late maturing cultivar produced higher yield under late sown condition.
- In a field trial at Vivekananda Parvatiya Krishi Anusandhan Shala, Almora find out that grain yield ranged from 2.12 tonnes/ha (local cultivar) to 4.02 tonnes/ha (VL-16 and Vl-42) while straw yield ranges from 4.14 (local cultivar) to 4.81 tonnes/ha (VL-16) (Prasad and Joshi, 1988).
- In field trial at Evara maize cultivar Acco 116, G17A, Hunter 520, PY 610 and G44 were tested (Growth period at 80-85, 90-95, 100-

105, 105-110,115-120, 120-125 days, respectively). Yield ranged from 4.28 tonnes/ha in Acco- 116 to 5.49 tonnes/ha in Hunter-5.20 (Laureno and Carolene, 1990).

- Patel *et al.* (1990) at GAU, Anand, Gujarat compared two maize cv. Vijay and Moti in a field trial and reported that variety Vijay produced higher green and dry matter yields.
- Bali *et al.* (1991) at Kashmir concluded that grain yield was higher with composite C6 than composite C8.
- Graybill *et al.* (1991) at Pennsylvania reported that longer season hybrid performed better when planted in late April or early May. Whereas the shorter season hybrid performed better when planted late May or early June.
- Patil (1993) at Maharashtra reported that maize cv. African Tall yielded 83 t green fodder/ha in 51 days than out yielding cv. Ganga Safed-2 and Ganga Safed-5.
- Jadhao *et al.* (1995) at Akola, Maharashtra find out that green and dry fodder yield of maize increased with increasing nitrogen @ 40 Kg to 80 Kg per hactare and were higher in African Tall than Manjri composite.

- Mittal *et al.* (1999) at Udaipur revealed that significantly higher grain yield (50.6 q/ha) and stover yield (75.89 q/ha) of maize was recorded for Mahi Dhaval over Navjot and Mahi kanchan varieties.

2.3.4 Nutrient Uptake

- In an experiment at Udaipur, Jain and Singh (1974) reported that content and uptake of nitrogen by various germ plasm in grain did not differ significantly. Stover of Vijay however, attained the highest content and uptake of nitrogen over Malan.
- Pal and Panwar (1975) at Amber revealed that maize cv. Ganga-2 contained higher nitrogen at each phonological stage over Vijay.
- Patel *et al.* (1990) at GAU, Anand, observed that maize variety Vijay produced higher crude protein yield over cv. Moti.
- Jadhoa *et al.* (1995) at Akola, Maharashtra reported that maize crude protein content increased with increasing rate of nitrogen application and were higher in African Tall than Manjri composite.

- Firdous *et al., (1995) at* Univ. of Agriculture, Pakistan reported that digestibility of dry matter and NDF, ADF in all plants was affected by the type of cultivars.
- Mittal *et al.* (1999) at R.C.A., Udaipur in their comparison of three varieties of maize find out that variety Mahi Dhaval recorded significantly higher N, P and K ~~uptake~~ by grain and stover at harvest over Navjot and Mahi Kanchan.

MATERIAL & METHODS

3. MATERIALS AND METHODS

The details of material used, experimental procedure followed and techniques adopted during the course of investigation are described in this chapter.

3.1 EXPERIMENTAL SITE

The present investigation was carried out at Forage Research Project Farm, Gujarat Agricultural University, Anand during the *kharif* season of 1999-2000. It is geographically situated at 22° 35' N latitude and 72° 55' E longitude with an altitude of 45.1 meters above mean sea level.

3.2 CLIMATIC AND WEATHER CONDITIONS

The climate of this region is subtropical., Usually, monsoon commences by the second week of June and retreats by the end of September with an average annual rainfall of about 868 mm. Practically rainfall does not occur in winter and summer seasons almost in all the parts of Gujarat, July and August are the months of heavy precipitation. Winter is fairly cold and sets in the month of November and continues till the middle of February.

Summer is hot dry, which commences from mid of February and ends in June. In general, summer is fairly dry and hot, winter is fairly cool and dry, while monsoon is warm and moderately humid.

The mean weekly weather parameters recorded at the B.A. College of Agriculture, Agronomy Farm, GAU, Anand during the period of investigation in Table 3.1 and Fig. 1.

3.3 SOIL CHARACTERISTICS

The soil of the experimental field was sandy loam in nature (Alluvial soil, *Orchrept*) locally known as "*Goradu-soil*". The soil is well-drained, light brown in colour, very deep and fairly retentive of moisture. It is poor in organic matter, medium in available phosphorus and rich in available potassium. The physico-chemical properties of the experimental fields are presented in Table 3.2.

3.4 EXPERIMENTAL DETAILS

3.4.1 Experimental Design

The experiment entitled "Effect of dates of sowing and stages of harvesting on forage yield and quality of maize varieties" was laid out in Split Plot Design with three replications.

Table 3.1: Meteorological data of crop season during the year 1999-2000

Date and month	Std Week	RF mm	MAX T °C	MIN T °C	Mean °C	Bright Sunshine hours	EP mm	Mean RH
21-27 June	26	0.0	34.7	26.6	30.6	8.2	6.8	68
28 Jun-4 July	27	5.0	34.5	26.3	30.4	5.5	6.1	70
5 – 11 July	28	33.0	32.2	25.9	29.1	4.1	4.6	80
12 – 18 July	29	138.5	30.2	25.6	27.9	0.3	2.2	88
19 – 25 July	30	3.0	30.8	25.8	28.3	1.5	3.3	81
26 Jul–1 Aug	31	9.6	30.7	25.3	28.0	1.8	3.8	81
2- 8 Aug	32	20.2	29.6	25	27.3	0.6	2.4	86
9-15 Aug	33	0.0	32.6	25.4	29.0	5.1	5.0	74
16-22 Aug	34	0.0	33.2	25.0	29.1	5.4	5.2	69
23-29 Aug	35	0.0	33.5	24.9	29.2	6.5	6.0	70
30Aug-4Sept	36	0.0	33.7	25.6	29.6	6.6	6.3	68
5-12 Sept	37	7.4	33.5	24.9	28.7	5.4	4.7	77
13-19 Sept	38	0.0	33.1	24.6	28.8	5.4	5.1	80
20-26 Sept	39	2.8	34.5	25.0	29.7	7.4	5.7	71
27sept-3 Oct	40	4.0	34.4	24.4	28.9	6.1	4.1	75
4-10 Oct	41	18.4	32.5	26.3	27.9	3.5	3.0	81
11-17 Oct	42	0.0	34.8	19.4	27.1	9.9	4.8	61
18-24 Oct	43	0.0	35.3	18.0	26.6	9.8	5.2	53

Fig. 1 Meteorological data during crop season in the year 1999-2000

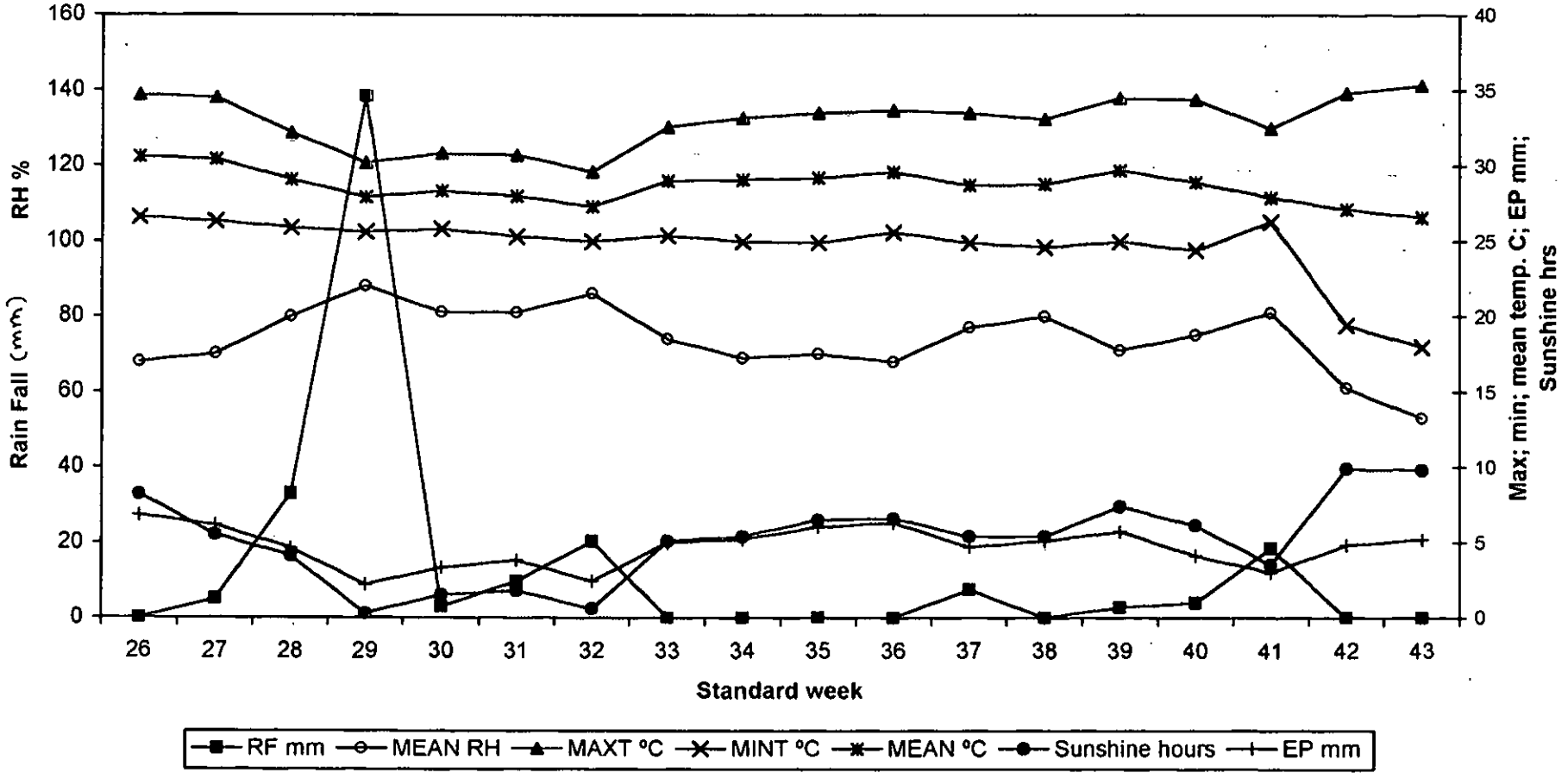


Table 3.2: Physico-Chemical properties of the experimental soil

Sr. No	Properties	Soil depth (cm)		Method adopted
		0.15	15-30	
1.	**PHYSICAL PROPERTIES**			
(i)	Coarse sand (%)	0.55	0.50	Beaker and International pipette method (piper, 1966)
(ii)	Fine sand (%)	82.90	84.90	
(iii)	Silt (%)	10.5	10.00	
(iv)	Clay (%)	5.50	4.85	
(v)	Textural class	sandy loam		
2	**CHEMICAL PROPERTIES**			
(i)	Soil pH (1:2.5 soil: water)	7.8	7.6	pH meter (Jackson, 1973)
(ii)	Organic carbon (%)	0.38	0.40	Walkley and Black method (Jackson, 1973)
(iii)	Total Nitrogen (%)	0.035	0.034	Kjeldhal's method (Jackson, 1973)
(iv)	Available P_2O_5 (kg/ha)	43.5	41.4	Olsen's method (Chopra &Kanwar, 1976)
(v)	Available K_2O(kg/ha)	361.8	281.6	Flame photometric method (Jackson, 1973)
(v)	EC(dSm^{-1} at 25°C)	0.16	0.21	Conductivity meter (Jackson, 1973)

3.4.2 Details Of Treatments

The treatment consisted of all possible combinations of two varieties, three dates of sowing and three cutting stages. The allotment of the treatments to different plots in each replication has been made by referring random number table, which was suggested by Panse and Sukhatme (1967). The details of the treatments and all possible combinations with symbols are given below.

Treatments: 18

[A] Main Plot: Three

(i) Date of sowing (D) : Three

(a) Sowing on 30th June D_1

(b) Sowing on 15th July D_2

(c) Sowing on 30th July D_3

[B] Subplots : Six (Combination of varieties and harvesting stage)

(i) Varieties (V): Two

(a) Gujarat Maize –2 V_1

(b) African Tall V_2

(ii) Harvesting stages (T): Three

(a) Tasseling stage T_1

(b) Silking stage T_2

(c) Milking stage T_3

Treatment Combinations

1	$D_1 V_1 T_1$
2	$D_1 V_1 T_2$
3	$D_1 V_1 T_3$
4	$D_1 V_2 T_1$
5	$D_1 V_2 T_2$
6	$D_1 V_2 T_3$
7	$D_2 V_1 T_1$
8	$D_2 V_1 T_2$
9	$D_2 V_1 T_3$
10	$D_2 V_2 T_1$
11	$D_2 V_2 T_2$
12	$D_2 V_2 T_3$
13	$D_3 V_1 T_1$
14	$D_3 V_1 T_2$
15	$D_3 V_1 T_3$
16	$D_3 V_2 T_1$
17	$D_3 V_2 T_2$
18	$D_3 V_2 T_3$

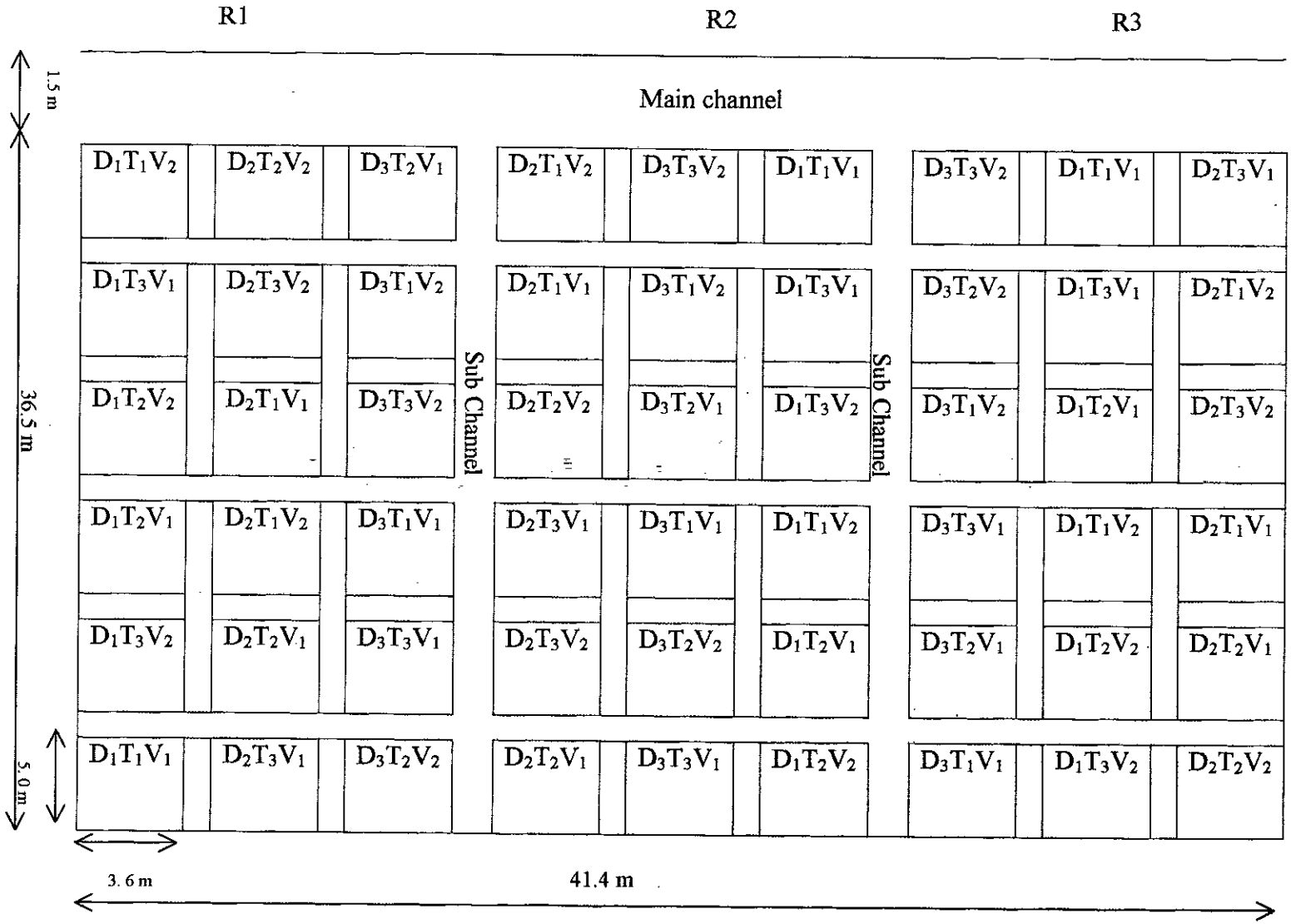
3.6 DETAILS OF FIELD OPERATIONS

The schedule of cultural operations carried out during the course of investigation is furnished in Table 3.3.

Table 3.3 Schedule of cultural operations

Sr. No	Cultural Operations		Date(s)
1.	Pre-sowing operations		
	(a) Ploughing		15.06.99
	(b) Harrowing		25.06.99
	(c) Planking		27.06.99
	(d) Layout		29.06.99
2.	Fertilizer application (@ 80 kgN/ha and 40 kg P_2O_5/ha)		
	(a) Basal dose (40 kgN/ha & 40 kg P_2O_5/ha)	D_1	30.06.99
		D_2	15.07.99
		D_3	30.07.99
	(b) Top dressing of N (40kgN/ha)	D_1	30.07.99
		D_2	14.08.99
		D_3	29.08.99
3.	Sowing	D_1	30.06.99
		D_2	15.07.99
		D_3	30.07.99
4.	Post harvesting operations		
	(A) Hand weeding		
	I Weeding	D_1	25.07.99
		D_2	04.08.99
		D_3	18.08.99
	II weeding	D_1	07.08.99
		D_2	16.08.99
		D_3	30.08.99
5.	Irrigation	D_1	20-07-99, 10-08-99
		D_2	10-08-99, 2-09-99, 20-09-99
		D_3	10-08-99, 5-09-99, 20-09-99, 10-10-99
6.	Crop Protection measures		
	Application of Carbofuran @ 25 kg/ha	D_1	30.06.99
		D_2	15.07.99
		D_3	30.07.99

Fig. 2. Layout plan of the Experiment



(6) Harvesting	DAS
(A)Gujarat Maize-2	
$D_1T_1V_1$	49
$D_1T_2V_1$	57
$D_1T_3V_1$	17
$D_2T_1V_1$	50
$D_2T_2V_1$	59
$D_2T_3V_1$	76
$D_3T_1V_1$	49
$D_3T_2V_1$	55
$D_3T_3V_1$	68
(B) African Tall	
$D_1T_1V_2$	67
$D_1T_2V_2$	77
$D_1T_3V_2$	93
$D_2T_1V_2$	64
$D_2T_2V_2$	73
$D_2T_3V_2$	88
$D_3T_1V_2$	62
$D_3T_2V_2$	70
$D_3T_3V_2$	86

3.6.1 Preparation Of Land

The experimental field was prepared by ploughing, harrowing followed by planking using tractor drawns implements. The stubbles of the previous crops and weeds are removed from the field. Thereafter, the clods were crushed by tractor drawn planker moves in both the direction to develop a good seedbed of required size.

3.6.2 Fertilizer And Pesticide Application

The full dose of phosphorus in form of single superphosphate and half of the nitrogen (Urea) were applied as basal and remaining half dose of nitrogen was applied as top dressing in the form of Urea at 30 days after sowing. To prevent attack of stem borer the carbofuran @ 25 kg/ha was applied while preparing the experimental plots.

3.6.3 Sowing And Post Sowing Operations

As per the schedule of treatments sowing was to be carried out on three different dates viz 30th June, 15th July and 30th July. The gross plot of size 5.0x3.6m was prepared. The furrows were opened manually in each plot at 30 cm apart and the seeds were sown @ 60 kg/ha manually in the previously opened furrows.

3.6.4 Irrigation

The irrigation was only applied when the crop attains stress conditions due to prolonged period of rains. The crop was irrigated with 60 mm depth each time as per the recommendation

of Gujarat Agricultural University for this crop thought the crop growth period.

3.6.5 Harvesting

The crop was harvested at tasseling stage, silking stage and milking stage as per the treatment. The border rows were harvested first and then the crop from each net plot was harvested and plot wise fresh weight was recorded.

3.7 BIOMETRIC OBSERVATIONS

The various growth and yield attributing characters of the crop was studied during the course of investigation, the details of which are given separately.

3.7.1 Growth Characters

3.7.1.1 Plant Height

Five plants were randomly selected and tagged for easy recognition and observation in each experimental plot. The height (cm) of the plants was measured from the ground level to the base of the last opened leaf and recorded at each harvest. The average height of plant was worked out and recorded for each plot.

3.7.1.2 Stem thickness

Stem thickness/girth was measured in cm from 2/3 lengths from the top of the plant at the time of harvest. It was measured by the vernier caliper.

3.7.1.3 Leaf length at harvesting

The leaf length of 5th leaf from the top of each of the tagged five plants was measured from the base of the leaf blade to its tip in cm.

3.7.1.4 Leaf width

The leaf selected for the measurement of leaf length was also used for measuring the leaf breadth. Leaf breadth was measured in the region of maximum leaf expansion.

3.7.2 Yield Attributing Characters

3.7.2.1 Plant Population At Harvesting

The final plant population was recorded from each net plot at the time of harvesting and mean values were worked out.

3.7.2.2 Number Of Leaves Per Plant

The number of leaves per plant was calculated by counting all leaves on each of the tagged plants including dry leaves at the time of harvesting.

3.7.2.3 Green Forage Yield

The plants from ring area of each plot were harvested first and collected. Then, the plants in the net plot area were harvested close to ground level and weight of produce was recorded for each plot separately.

3.7.2.4 Dry Matter Yield

The green plant sample from each net plot was randomly collected and weight the samples of 500g. Thereafter, samples were cut into small pieces, first air dried under shadow for about week period and then oven dried at 70°C to a constant weight. The dry matter weight was recorded separately for each treatment.

3.7.2.5 Dry matter content

The dry matter content was calculated by using the following formula

$$DM\% = \frac{\text{Dry matter yield (g)}}{\text{Green forage yield (g)}} \times 100$$

3.7.3 Biochemical studies

3.7.3.1 Crude protein content

The treatment wise oven dried maize samples first powdered using Willey Millard and nitrogen percentage was estimated by using modified kjeldahl's method (Jackson, 1973). Nitrogen percentage was multiplied by factor 6.25 (Dubetz and Wells, 1968) to obtain the protein content from green forage and was expressed as percentage on dry weight basis.

3.7.3.2 Crude protein yield

The crude protein per ha was worked out by employing the following formula

$$\text{CP Yield (q/ha)} = \frac{\text{Protein content in dry maize sample(\%)} \times \text{DMY (q/ha)}}{100}$$

3.7.3.3 Neutral detergent fibre content

It is an estimate of cell wall content of the forages. It is estimated by dissolving the cell content in detergent. It can be determined by thoroughly mixing and grinding of dry sample of each treatment gave an estimation of neutral detergent fibre (Von Soest and Wine, 1967).

3.7.3.4 *In Vitro* digestible dry matter content

Tilley and Terry (1963) have described a simple technique for determination of *in vitro* of the DMD or the OMD of small (0.5 g) samples of dried forages. It involves incubation first with rumen liquor.

The IVDMD was calculated by using the following formula

$$\text{IVDMD (\%)} = \frac{\text{Sample DM - (Undigested DM residue - DM blank)}}{\text{Sample dry matter}} \times 100$$

3.7.3.5 Digestible dry matter production

The DDM production was calculated by using the following formula

$$\text{DDM production (q/ha)} = \frac{\text{IVDMD content}}{\text{DM Yield (q/ha)}} \times 100$$

3.8 STATISTICAL ANALYSIS

The data obtained on various parameters were analysed by Analysis of variance method (Panse and Sukhatme, 1967). The total variable C10 and degree of freedom (n-1) were partitioned into different possible sources viz., replications, varieties (V), dates of sowing (D), harvesting stages (T), interactions and error. The significance of treatments was computed by 'F' test and critical differences at 5 per cent levels of significance were calculated where, the differences among the treatments were significant.

3.9 CORRELATION STUDIES

Correlation studies were carried out with a view to find out relationship among various factors which effect on forage yield and yield attributes as well as forage quality parameters. The simple correlation co-efficient(r) was calculated by means of computer by adopting the formula described by the Snedocor and Cochran (1967).

RESULTS

4. EXPERIMENTAL RESULTS

The results obtained in the present investigation on the effect of dates of sowing and stages of harvesting on forage yield and quality of maize varieties under Middle Gujarat Agro-climatic Zone-III are presented in this chapter. The data were subjected to statistical analysis to study the effect of treatments on various aspects of crop production like growth, forage yield attributes and forage yield as well as forage quality. All main effects and only the significant interactions are presented in tables and discussed.

4.1 Growth Attributing Characters

4.1.1 Final plant population per net plot

The mean data on number of final plant population per net plot as influenced by various treatments are given in Table 4.1.

(a) Effect of dates of sowing

The data revealed that final plant population per net plot was significantly influenced by various dates of sowing. The treatment D_1(30th June) had significantly more plant stand (215.61)

than treatment D_3 (30^{th} July).The D_1 was at par with treatment D_2 (15^{th} July).

Table 4.1: Plant population as influenced by dates of sowing, harvesting stages and varieties

Treatment	Plant population at harvest/net plot
Dates of sowing (D)	
D_1 (30^{th} June)	215.61
D_2 (15^{th} July)	214.33
D_3 (30^{th} July)	197.33
S.Em. ±	1.39
C.D. at 5 %	5.45
C.V. %	2.81
Harvesting stages (T)	
T_1 (Tasseling stage)	208.61
T_2 (Silking stage)	207.78
T_3 (Milking stage)	210.89
S.Em. ±	3.09
C.D. at 5 %	NS
Varieties (V)	
V_1 (Gujarat Maize- 2)	209.59
V_2 (African Tall)	208.58
S.Em. ±	2.52
C.D. at 5 %	NS
C.V. %	6.27

4.1.2 Plant height

The data in table at harvest plant height (cm) as influenced by various treatments are presented in Table 4.2.

(a) Effect of dates of sowing

The results of analysis of data on plant height recorded at harvesting indicated that differences due to various sowing dates were found significant. Early sowing of maize crop on 30th June recorded maximum plant height (218.68 cm) as compared to sowing on D_2 i.e., 15th July (207.68 cm) and D_3 i.e., 30th July (185.39cm), the latter two also differed significantly.

(b) Effect of harvesting stage

The harvesting of maize at milking stage (T_3) had significantly taller plant height (234.78 cm) as compared to T_1 i.e., tasseling stage (171.0 cm) and T_2 i.e., silking stage (205.97 cm). Each stage differed significantly for this trait.

(c) Effect of varieties

Maize variety African Tall showed significantly higher plant height (218.20 cm) than that of variety Gujarat Maize-2 (189.64 cm).

Table 4.2 : Plant height as influenced by dates of sowing, harvesting stages and varieties

Treatment	Plant height at harvest (cm)
Dates of sowing (D)	
D_1 (30^{th} June)	218.68
D_2 (15^{th} July)	207.68
D_3 (30^{th} July)	185.39
S.Em. ±	2.78
C.D. at 5 %	10.90
C.V. %	5.78
Harvesting stages (T)	
T_1 (Tasseling stage)	171.01
T_2 (Silking stage)	205.97
T_3 (Milking stage)	234.78
S.Em. ±	1.88
C.D. at 5 %	5.43
Varieties (V)	
V_1 (Gujarat Maize- 2)	189.64
V_2 (African Tall)	218.20
S.Em. ±	1.54
C.D. at 5 %	4.43
C.V. %	3.91
Significant interaction	D XV

(d) Plant height as influenced by D x V interaction

The interaction effect of dates of sowing and varieties (D x V) on plant height was found significant and mean data are presented in Table 4.3.

Table 4.3 : Plant height as influenced by D X V interaction

Dates of sowing (D)	Plant height (cm)	
	Varieties (V)	
	V_1	V_2
D_1	187.67	249.70
D_2	203.26	212.11
D_3	178.01	192.78
S.Em. ±	3.26	
C.D. at 5 %	9.41	

The data on plant height as influenced by interaction effect of D x V indicated that treatment combination of D_1V_2 (30^{th} June and African Tall) recorded significantly taller plant height (249.70 cm) as compared to rest of the treatments combinations. Treatment combination of D_3V_1 (30^{th} July and GM-2) have the smallest plants height (178.01 cm). Variety V_2 favoured D_1 sowing while variety V_1 respond to D_2 favourably.

4.1.3 Stem thickness

The data on stem thickness as influenced by various treatments are presented in Table 4.4.

Table 4.4 : Stem thickness as influenced by dates of sowing, harvesting stages and varieties

Treatment	Stem thickness at harvest (cm)
Dates of sowing (D)	
D_1 (30^{th} June)	1.33
D_2 (15^{th} July)	1.30
D_3 (30^{th} July)	1.28
S.Em. ±	0.01
C.D. at 5 %	NS
C.V. %	4.06
Harvesting stages (T)	
T_1 (Tasseling stage)	1.19
T_2 (Silking stage)	1.33
T_3 (Milking stage)	1.39
S.Em. ±	0.01
C.D. at 5 %	0.03
Varieties (V)	
V_1 (Gujarat Maize- 2)	1.28
V_2 (African Tall)	1.32
S.Em. ±	0.01
C.D. at 5 %	0.02
C.V. %	3.03
Significant interaction	D X V and T X V

(a) Effect of harvesting stages on stem thickness

The data revealed that various harvesting stages of maize had significant effect on stem thickness. The maize crop harvested at milking stage had significantly thicker stem (1.39 cm) as compared to T_1 i.e., Tasseling stage (1.19 cm) and T_2 i.e., silking stage (1.33cm).

(b) Effect of varieties

The data indicated that there was differential effect of varieties on stem thickness.The African Tall variety (V_2) recorded significantly thicker stem (1.32 cm) as compared to V_1 i.e., GM-2 (1.28 cm).

(c) Effect of D x V interaction on stem thickness

The data regarding interaction D X V of dates of sowing and varieties are presented in Table 4.5.

Table 4.5 : Stem thickness as influenced by D X V interaction

Dates of sowing (D)	Stem thickness (cm)	
	Varieties (V)	
	V_1	V_2
D_1	1.24	1.42
D_2	1.33	1.27
D_3	1.27	1.28
S.Em. ±	0.02	
C.D. at 5 %	0.05	

The data revealed that treatment combination of D_1V_2 (30^{th} June and African Tall) recorded significantly thicker stem (1.42 cm) than rest of the treatment combinations. The lowest stem thickness (1.24 cm) was observed in treatment combination D_1V_1 (30^{th} June and GM-2), which was at par with D_3V_1, D_2V_2 and D_3V_2.Both the varieties differed in stem thickness when seeded on D_1 and D_2, but failed to show difference in stem thickness under D_3 condition. V_1 at D_2 and V_2 at D_1 gave significantly thicker stem.

(d) Effect of T x V interaction on stem thickness

The data for significant interaction of T x V on stem thickness are presented in Table 4.6.

Table 4.6: Effect of T X V interaction on stem thickness

Harvesting stages (T)	Stem thickness (cm)	
	Varieties (V)	
	V_1	V_2
T_1	1.22	1.26
T_2	1.29	1.36
T_3	1.33	1.45
S.Em. ±	0.01	
C.D. at 5 %	0.04	

The data regarding stem thickness of maize as influenced by T x V interaction showed that treatment

combination of T_3V_2 (Milking stage and African Tall) had significantly higher stem thickness (1.45 cm) as compared to other treatment combinations. The lowest stem thickness (1.22 cm) was noted in treatment combination of T_1V_1 i.e., tasseling stage and GM-2.At T_2 and T_3 stages, the variety African Tall showed significantly thicker stem than Gujarat Maize –2.

4.1.4 Leaf length

The data on average leaf length of maize at harvesting as influenced by different planting dates, harvesting stages and varieties are given in Table 4.7.

(a) Effect of sowing dates

The results of analysis of leaf length indicated that differences due to various sowing dates were found significant. Early sowing of maize on 30th June (D_1) recorded significantly longer leaf (89.03 cm) than delayed sowing on 30 th July(D_3).However, it was at par with 15th July (D_2).

(b) Effect of harvesting stages

The harvesting of maize crop at milking stage (T_3) resulted in significantly higher leaf length (90.87 cm) as compared

to T_1 i.e., tasseling stage (78.72 cm) and T_2 i.e., silking stage (85.54 cm).

Table 4.7: Leaf length as influenced by various treatments

Treatment	Leaf length (cm)
Dates of sowing (D)	
D_1 (30th June)	89.03
D_2 (15th July)	87.74
D_3 (30th July)	78.36
S.Em. ±	0.99
C.D. at 5 %	3.88
C.V. %	4.93
Harvesting stages (T)	
T_1 (Tasseling stage)	78.72
T_2 (Silking stage)	85.54
T_3 (Milking stage)	90.87
S.Em. ±	0.95
C.D. at 5 %	2.76
Varieties (V)	
V_1 (Gujarat Maize- 2)	74.71
V_2 (African Tall)	95.37
S.Em. ±	0.78
C.D. at 5 %	2.25
C.V. %	4.76
Significant interaction	D X V

(c) Effect of varieties

The data revealed that maize variety African Tall (V_2) had significantly longer leaf (95.37 cm) as compared to variety V_1 i.e., Gujarat Maize-2 (74.71 cm).

(d) Effect of D x V interaction on leaf length (cm)

The interaction effect of dates of sowing and varieties on leaf length of maize was found significant and mean data are presented in Table 4.8.

Table 4.8: Leaf length as influenced by D X V interaction

Dates of sowing (D)	Leaf length (cm)	
	Varieties (V)	
	V_1	V_2
D_1	74.78	103.29
D_2	79.02	96.47
D_3	70.34	86.37
S.Em. ±	1.65	
C.D. at 5 %	4.77	

The data pertaining to leaf length as influenced by interaction effect D x V indicated that treatment combination D_1V_2 (30^{th} June and African Tall) recorded significantly higher leaf length (103.29 cm) as compared to rest of the treatment combinations. The lowest leaf length (70.34 cm) was noted in treatment combination of D_3V_1 (30^{th} July and Gujarat maize-2). Variety V_1 at D_2 had maximum leaf length followed by D_1,

whereas variety V_2 at D_1 had significantly more leaf length and at D_2 and D_3.

4.1.5 Leaf width

The mean data on leaf width of maize as influenced by dates of sowing, harvesting stages and varieties are given in Table 4.9.

(a) Effect of dates of sowing

The data revealed that leaf width of maize was significantly affected by different sowing dates. Early sowing of maize on 30th June (D_1) exerted significantly higher leaf width (6.83 cm) as compared to late sowing on D_3 i.e., 30th July (6.17 cm) and it was at par with D_2 i.e., 15th July which have leaf width of 6.64 cm.

(b) Effect of harvesting stages

Effect of harvesting stage of maize was significant with respect to leaf width. The harvesting of maize crop at milking stage (T_3) exhibited significantly higher leaf width (7.03 cm) as compared to T_1 i.e., Tasseling stage and T_2 i.e., silking stage which have 6.00 cm and 6.61 cm leaf width, respectively.

Table 4.9: Leaf width as influenced by various treatments

Treatment	Leaf width at harvest (cm)
Dates of sowing (D)	
D_1 (30th June)	6.83
D_2 (15th July)	6.64
D_3 (30th July)	6.17
S.Em. ±	0.09
C.D. at 5 %	0.37
C.V. %	6.08
Harvesting stages (T)	
T_1 (Tasseling stage)	6.00
T_2 (Silking stage)	6.61
T_3 (Milking stage)	7.03
S.Em. ±	0.07
C.D. at 5 %	0.19
Varieties (V)	
V_1 (Gujarat Maize- 2)	6.28
V_2 (African Tall)	6.81
S.Em. ±	0.05
C.D. at 5 %	0.15
C.V. %	4.24
Significant interaction	D X T and D X V

(c) Effect of varieties

The data revealed that leaf width of maize was significantly influenced by varieties. Variety African Tall (V_2) showed significantly higher leaf width (6.81 cm) as compared to Gujarat Maize-2 (V_2) which have 6.28 cm leaf width.

(d) Leaf width as influenced by D x T interaction

The interaction effect of D x T was found significant for leaf width of maize. The data pertaining to interaction are given in Table 4.10.

Table 4.10: Leaf width as influenced by D X T interaction

Dates of sowing (D)	Leaf width (cm)		
	Harvesting stages (T)		
	T_1	T_2	T_3
D_1	6.41	6.83	7.25
D_2	6.17	6.79	6.96
D_3	5.43	6.21	6.80
S.Em. ±	0.09		
C.D. at 5 %	0.27		

The data presented in Table 4.10 indicated that sowing of maize on 30th June and harvesting at milking stage (D_1T_3) recorded significantly higher leaf width (7.25 cm) than other treatment combinations. The lowest leaf width (5.43 cm) was observed in D_3T_1 (30th July and Tasseling stage).

(e) Leaf width as influenced by D x V interaction

The interaction effect of D x V was found to be significant for leaf width (cm). The data pertaining to interaction are given in Table 4.11.

Table 4.11: Leaf width as influenced by D X V interaction

Dates of sowing (D)	Leaf width (cm)	
	Varieties (V)	
	V_1	V_2
D_1	6.42	7.24
D_2	6.30	6.98
D_3	6.12	6.22
S.Em. ±	0.11	
C.D. at 5 %	0.33	

Among the different treatment combinations, D_1V_2 recorded significantly higher leaf width (7.24cm) than all the other treatment combinations except D_2V_2 (6.98 cm).

4.2 Yield Attributing Characters

4.2.1 Number of leaves /plant

The mean data on total number of leaves per plant of maize crop was influenced by sowing dates, harvesting stages and varieties are given in Table 4.12.

Table 4.12: Effect of sowing dates, harvesting stages and varieties on number of leaves per plant

Treatment	Number of leaves / plant at harvest
Dates of sowing (D)	
D_1 (30th June)	13.40
D_2 (15th July)	12.62
D_3 (30th July)	11.28
S.Em. ±	0.22
C.D. at 5 %	0.85
C.V. %	7.42
Harvesting stages (T)	
T_1 (Tasseling stage)	10.77
T_2 (Silking stage)	12.66
T_3 (Milking stage)	13.88
S.Em. ±	0.12
C.D. at 5 %	0.35
Varieties (V)	
V_1 (Gujarat Maize- 2)	11.55
V_2 (African Tall)	13.32
S.Em. ±	0.12
C.D. at 5 %	0.29
C.V. %	4.15
Significant interaction	D X T and D X V

(a) Effect of sowing dates

The data revealed that total number of leaves per plant was significantly influenced by sowing dates. Sowing of maize crop on 30th June (D_1) recorded significantly higher total number of leaves per plant (13.40) than 30th July D_3(11.28). However, it was at par with 15th July, D_2 (12.62).

(b) Effect of harvesting stages

The effect of harvesting stages on total number of leaves per plant was found significant The maize crop harvested at milking stage (T_3) recorded significantly higher total number of leaves per plant(13.88) as compared to tasseling stage (T_1) and silking stage (T_2) which showed 10.77 & 12.66 total number of leaves per plant, respectively.

(c) Effect of varieties

The data indicated that total number of leaves per plant differed significantly due to varieties. The variety African Tall (V_2) exhibited significantly higher total number of leaves per plant (13.32) as compared to Gujarat maize-2 (V_1) which has 11.55 total number of leaves per plant.

(d) Effect of D x T interaction on total number of leaves per plant

The interaction effect of D x T was found significant for total number of leaves per plant. The data pertaining to the interaction are given in Table 4.13.

Table 4.13: Interaction effect of D X T on total number of leaves per plant

Dates of sowing (D)	Total number of leaves/plant		
	Harvesting stages (T)		
	T_1	T_2	T_3
D_1	11.57	13.62	15.02
D_2	10.65	12.98	14.22
D_3	10.08	11.37	12.40
S.Em. ±	0.17		
C.D. at 5 %	0.50		

The data presented in Table 4.13 indicated that treatment combination of D_1T_3 (30^{th} June and milking stage) produced significantly maximum total number of leaves per plant (15.02) than other treatment combinations.A treatment combination of D_3T_1 showed the lowest total number of leaves per plant (10.08).

(e) Total number of leaves as influenced by D x V interaction

The interaction effect of D x V was found significant for total numbers of leaves per plant. The data of interaction of D x V are given in Table 4.14.

Table 4.14: Interaction effect of D X V on total number of leaves per plant

Dates of sowing (D)	Total number of leaves/plant	
	Varieties (V)	
	V_1	V_2
D_1	11.71	15.09
D_2	12.50	12.73
D_3	10.43	12.13
S.Em. ±	0.21	
C.D. at 5 %	0.61	

Among the different treatment combinations of D x V, D_1V_2 combination recorded significantly the highest total number of leaves per plant (15.09) while D_3V_1 had the lowest total number of leaves per plant (10.43).

4.2.2 Green forge yield

The data pertaining to green forage yield (GFY) as influenced by various dates of sowing, harvesting stages and varieties are presented in Table 4.15, and Fig 3.

(a) Effect of dates of sowing

The data revealed that GFY of maize was significantly influenced by dates of sowing. Early sowing of

Table 4.15: Effect of sowing dates, harvesting stages and varieties on green forage yield of maize

Treatment	Green forage yield (q/ha)
Dates of sowing (D)	
D_1 (30^{th} June)	382.8
D_2 (15^{th} July)	351.5
D_3 (30^{th} July)	280.3
S.Em. ±	11.5
C.D. at 5 %	45.2
C.V. %	14.37
Harvesting stages (T)	
T_1 (Tasseling stage)	273.1
T_2 (Silking stage)	330.7
T_3 (Milking stage)	415.7
S.Em. ±	7.6
C.D. at 5 %	22.0
Varieties (V)	
V_1 (Gujarat Maize- 2)	296.4
V_2 (African Tall)	383.0
S.Em. ±	6.23
C.D. at 5 %	18
C.V. %	9.53
Significant interaction	D X V

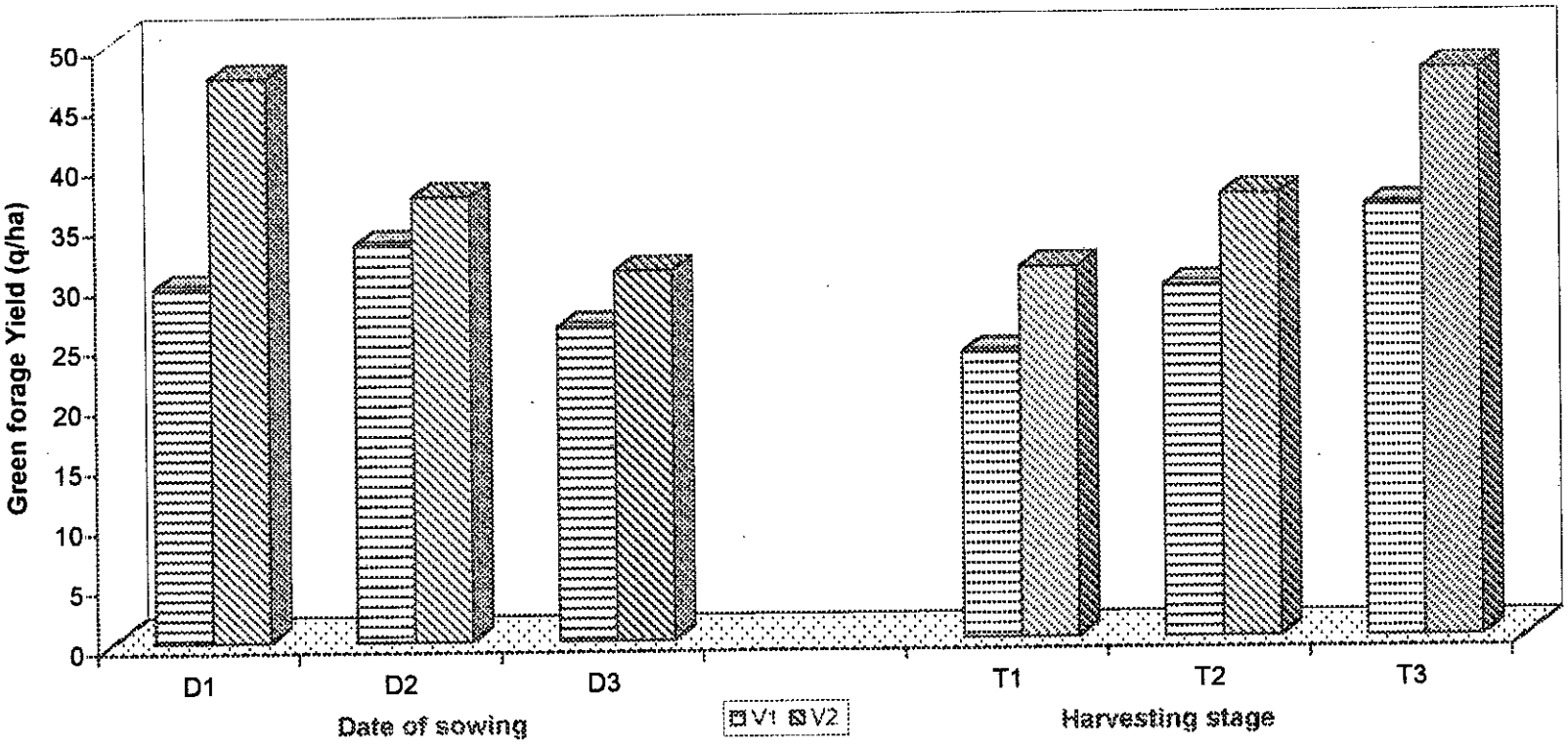


Fig. 3. Effect of sowing dates, harvesting stages and varieties on GFY of maize

maize crop on 30th June produced significantly higher GFY (382.8 q/ha) than late sowing on 30th July (280.3 q/ha). However sowing of maize crop on 15th July (D_2) was at par with sowing of maize crop on 30th June (D_1).

(b) Effect of harvesting stages

The harvesting of maize crop at milking stage (T_3) produced significantly higher GFY (415.7 q/ha) as compared to early harvesting at tasseling stage, T_1(373.1 q/ha) and silking stage T_2(330.7 q/ha). The corresponding increased of GFY in milking stage to the tune of 52.21 and 25.70 per cent, respectively over tasseling and silking stages.

(c) Effect of varieties

Between two varieties, African Tall, V_2 gave significantly higher GFY (383.0 q/ha) as compared to variety Gujarat maize-2,V_1 which gave 296.49/ha.

(d) Effect of D x V interaction on green forage yield

The interaction effect D x V was found to be significant for GFY. The data pertaining to the same are presented in Table 4.16.

Table 4.16: Interaction effect of D X V on green forage yield

Dates of sowing (D)	Green forage yield (q/ha)	
	Varieties (V)	
	V_1	V_2
D_1	295.1	470.4
D_2	332.2	370.9
D_3	262.2	308.4
S.Em. ±	13.2	
C.D. at 5 %	38.2	

The data showed that treatment combination of D_1V_2 (30^{th} June and African Tall) was remained at the top and produced significantly higher GFY (470.4 q/ha) as compared to other treatment combinations. The treatment combination of D_3V_1 (30^{th} July and GM-2) has produced the lowest GFY (262.1 q/ha).

4.2.3 Dry matter content (%)

The data on dry matter content as influenced by different treatments are presented in Table 4.17 and graphically depicted in Fig.4.

(a) Effect of harvesting stages

The data in Table 4.17 indicate that harvesting stage had a significant influence on dry matter content. The harvesting of maize crop at milking stage, T_3 had significantly higher dry matter accumulation (22.96%) as compared to early harvesting of maize at tasseling stage, T_1 and at silking stage, T_2, those

treatments accumulates 17.77% and 22.21% dry matter content, respectively.

Table 4.17: Effect of sowing dates, harvesting stages and varieties on dry matter content of maize

Treatment	Dry matter content (%)
Dates of sowing (D)	
D_1 (30th June)	22.23
D_2 (15th July)	19.91
D_3 (30th July)	19.81
S.Em. ±	0.75
C.D. at 5 %	NS
C.V. %	15.45
Harvesting stages (T)	
T_1 (Tasseling stage)	17.77
T_2 (Silking stage)	21.21
T_3 (Milking stage)	22.96
S.Em. ±	0.35
C.D. at 5 %	1.00
Varieties (V)	
V_1 (Gujarat Maize- 2)	19.87
V_2 (African Tall)	21.43
S.Em. ±	0.28
C.D. at 5 %	0.82
C.V. %	7.12
Significant interaction	D X V

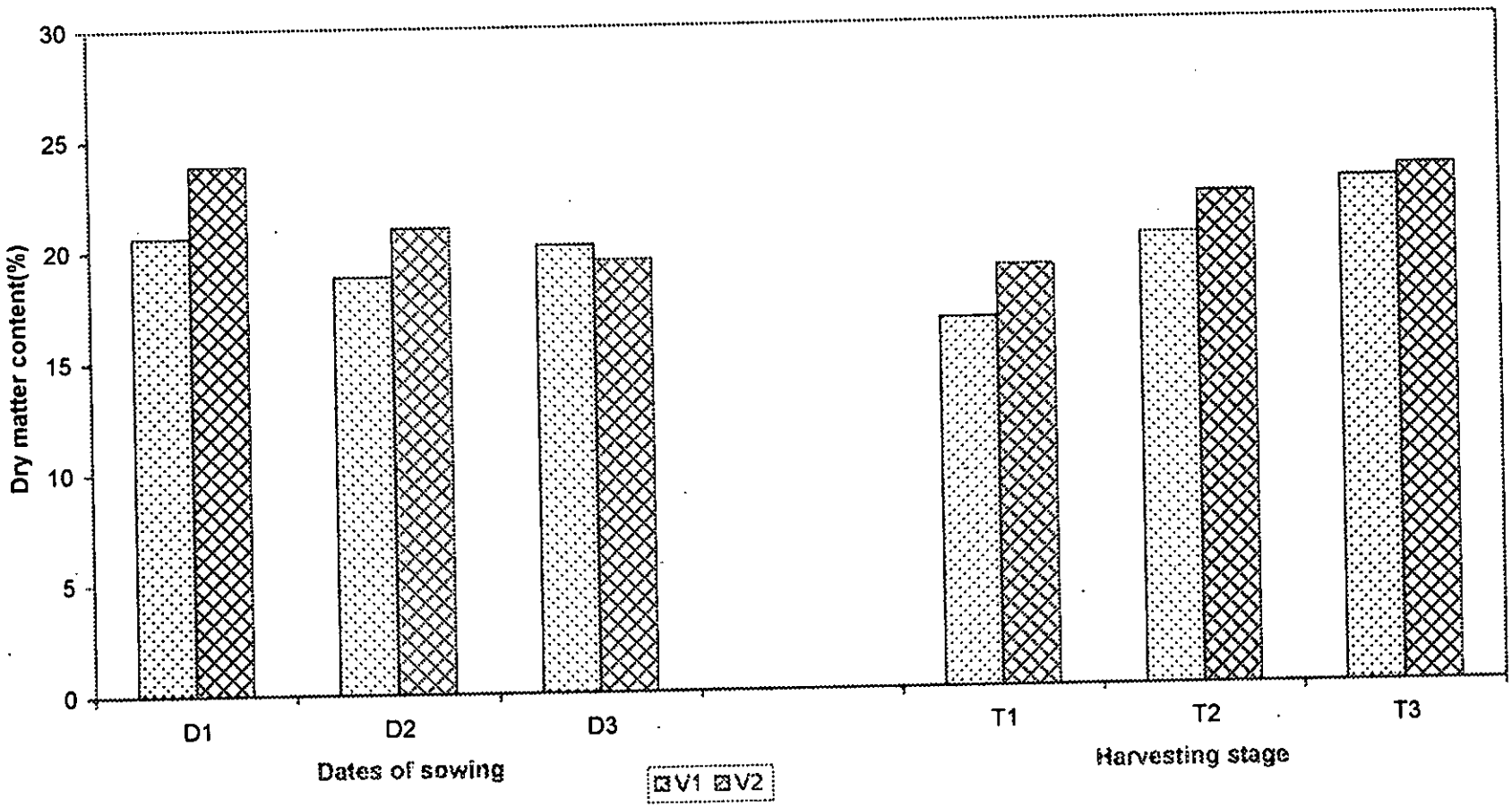


Fig. 4. Effect of sowing dates, harvesting stages and varieties on dry matter content of maize

(b) Effect of varieties

The data showed that dry matter content was significantly affected by varieties. The variety African Tall, V_2 accumulates significantly higher dry matter content (21.43%) as compared to Gujarat maize-2 (19.87%).

(c) Effect of D x V interaction on dry matter content

The interaction effect of D x V was found significant for dry matter content. The data pertaining to this interaction are given in Table 4.18.

Table 4.18: Interaction effect of D X V on dry matter content

Dates of sowing (D)	Dry matter content (%)	
	Varieties (V)	
	V_1	V_2
D_1	20.63	23.83
D_2	18.81	21.00
D_3	20.16	19.47
S.Em. ±	0.60	
C.D. at 5 %	1.73	

Among the different treatment combinations of D x V, D_1V_2 accumulates significantly higher dry matter content (23.83%) as compared to other treatment combinations. The D_2V_1 accumulates the lowest dry mater content (18.81%) which was at par with D_3V_2(19.47%) and D_3V_1(20.16%).

4.2.4 Dry matter yield

The data on dry matter yield as influenced by various sowing dates, harvesting stage and varieties are given in Table 4.19 and graphically presented in Fig.5.

(a) Effect of sowing date

The results presented in Table 4.19 indicate that different dates of sowing had significant influence on dry matter yield (DMY). The early sowing of maize crop on 30th June produced significantly higher DMY (88.15 q/ha) over delayed sowing of maize crop on 15th July (71.15 q/ha) and 30th July (58.87 q/ha).The corresponding reduction in DMY due to late sowing of maize crop on D_2 and D_3 to the tune of 23.9 and 49.7 per cent, respectively when it was compared with the early sowing of maize crop on 30th June (D_1).

(b) Effect of harvesting stage

The effect of harvesting stage was significant with respect to DMY. The harvesting of maize crop at milking stage(T_3) showed its superiority by producing significantly higher DMY (96.33 q/ha) than harvesting of maize crop at tasseling and silking stages. The corresponding increase of DMY at milking stage

was of 95.0 and 32.9 per cent over tasseling stage and silking stage, respectively.

Table 4.19: Effect of sowing dates, harvesting stages and varieties on dry matter yield of maize

Treatment	Dry matter yield (q/ha)
Dates of sowing (D)	
D_1 (30th June)	88.15
D_2 (15th July)	71.15
D_3 (30th July)	58.87
S.Em. ±	3.69
C.D. at 5 %	14.50
C.V. %	21.55
Harvesting stages (T)	
T_1 (Tasseling stage)	49.35
T_2 (Silking stage)	72.48
T_3 (Milking stage)	96.33
S.Em. ±	2.07
C.D. at 5 %	6.00
Varieties (V)	
V_1 (Gujarat Maize- 2)	60.06
V_2 (African Tall)	85.39
S.Em. ±	1.69
C.D. at 5 %	4.90
C.V. %	12.13
Significant interaction	D X V and DX T X V

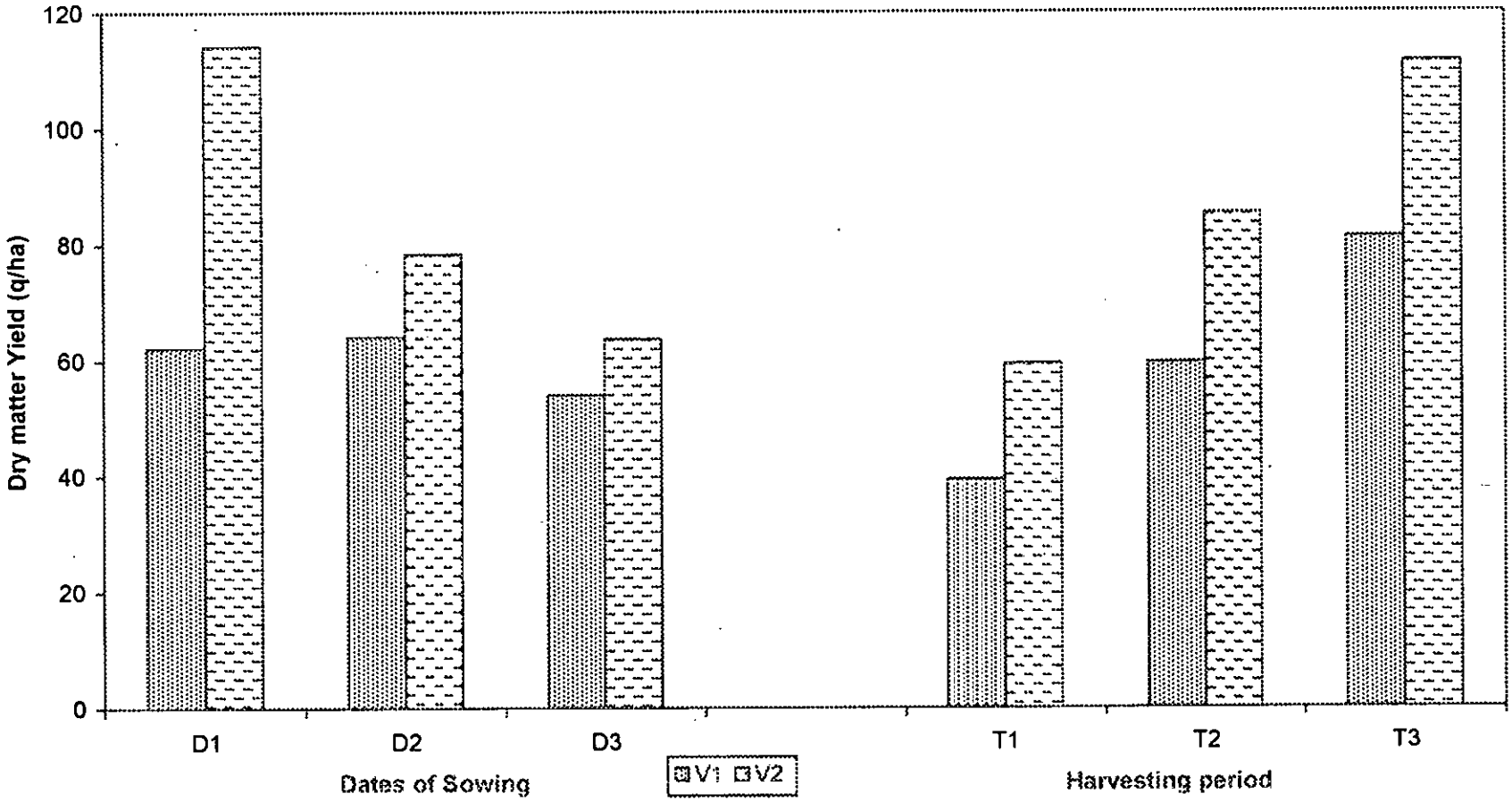


Fig. 5. Effect of sowing dates, harvesting stages and varieties on DMY of maize

(c) Effect of varieties

It is evident from data that the variety African Tall was found significantly superior for DMY (85.39 q/ha) than Gujarat Maize-2 (60.06 q/ha) , which was 42.0 per cent higher than the later.

(d) Effect of D x V interaction on dry matter yield

The interaction effect of D x V was found significant for DMY. The data pertaining to this interaction are tabulated in Table 4.20.

Table 4.20: Interaction effect of D X V on dry matter yield

Dates of sowing (D)	Dry matter yield (q/ha)	
	Varieties (V)	
	V_1	V_2
D_1	62.14	114.16
D_2	64.05	78.25
D_3	54.00	63.73
S.Em. ±	3.60	
C.D. at 5 %	10.39	

The data showed that sowing of maize variety African Tall, V_2 on 30th June produced significantly higher DMY (114.16 q/ha) than other treatment combinations. The minimum DMY (54.00 q/ha) was obtained with the treatment combination of D_3V_1.

(c) Effect of D x T x V interaction on dry matter yield

The data of significant interaction effect of D x T x V on DMY are presented in Table 4.21.

Table 4.21: Interaction effect of D X T X V on dry matter yield

Harvesting stages varieties	Dry matter yield (q/ha)		
	Dates of sowing		
	D_1	D_2	D_3
T_1V_1	43.78	40.13	34.13
T_1V_2	77.77	58.11	42.18
T_2V_1	62.67	62.22	53.81
T_2V_2	112.63	78.75	64.79
T_3V_1	79.96	89.79	74.06
T_3V_2	152.08	97.88	84.23
S.Em. ±	5.09		
C.D. at 5 %	14.70		

The data in Table 4.21 indicated that significantly higher DMY was obtained with treatment combination of $D_1T_3V_2$ (152.08 q/ha) over other treatment combinations. The lowest DMY (34.13 q/ha) was obtained by the treatment combination of $D_3T_1V_1$. The increase of DMY in $D_1T_3V_2$ was to the tune of 345.5 per cent over $D_3T_1V_1$.

4.3 Biochemical Studies

4.3.1 Crude protein content

The data related to crude protein (CP) content as affected by various treatments are given in Table 4.22 and graphically depicted in Fig.6.

(a) Effect of harvesting stage

The examination of data in Table 4.22 clearly indicated that harvesting of maize crop at tasseling stage (T_1) synthesized significantly higher CP content (6.92%) as compared to harvesting of maize crop at silking stage (6.62%) and at milking stage (6.41 %) and which were differed significantly with each other.

(b) Effect of varieties

The data presented in Table 4.22 showed that variety Gujarat Maize-2 (V_1) synthesized significantly higher CP content (6.85%) than variety African Tall (6.45%).

Table 4.22: Effect of sowing dates, harvesting stages and varieties on crude protein content

Treatment	Crude protein content (%)
Dates of sowing (D)	
D_1 (30th June)	6.69
D_2 (15th July)	6.64
D_3 (30th July)	6.62
S.Em. ±	0.02
C.D. at 5 %	NS
C.V. %	1.08
Harvesting stages (T)	
T_1 (Tasseling stage)	6.92
T_2 (Silking stage)	6.62
T_3 (Milking stage)	6.41
S.Em. ±	0.04
C.D. at 5 %	0.12
Varieties (V)	
V_1 (Gujarat Maize- 2)	6.85
V_2 (African Tall)	6.45
S.Em. ±	0.03
C.D. at 5 %	0.10
C.V. %	2.60

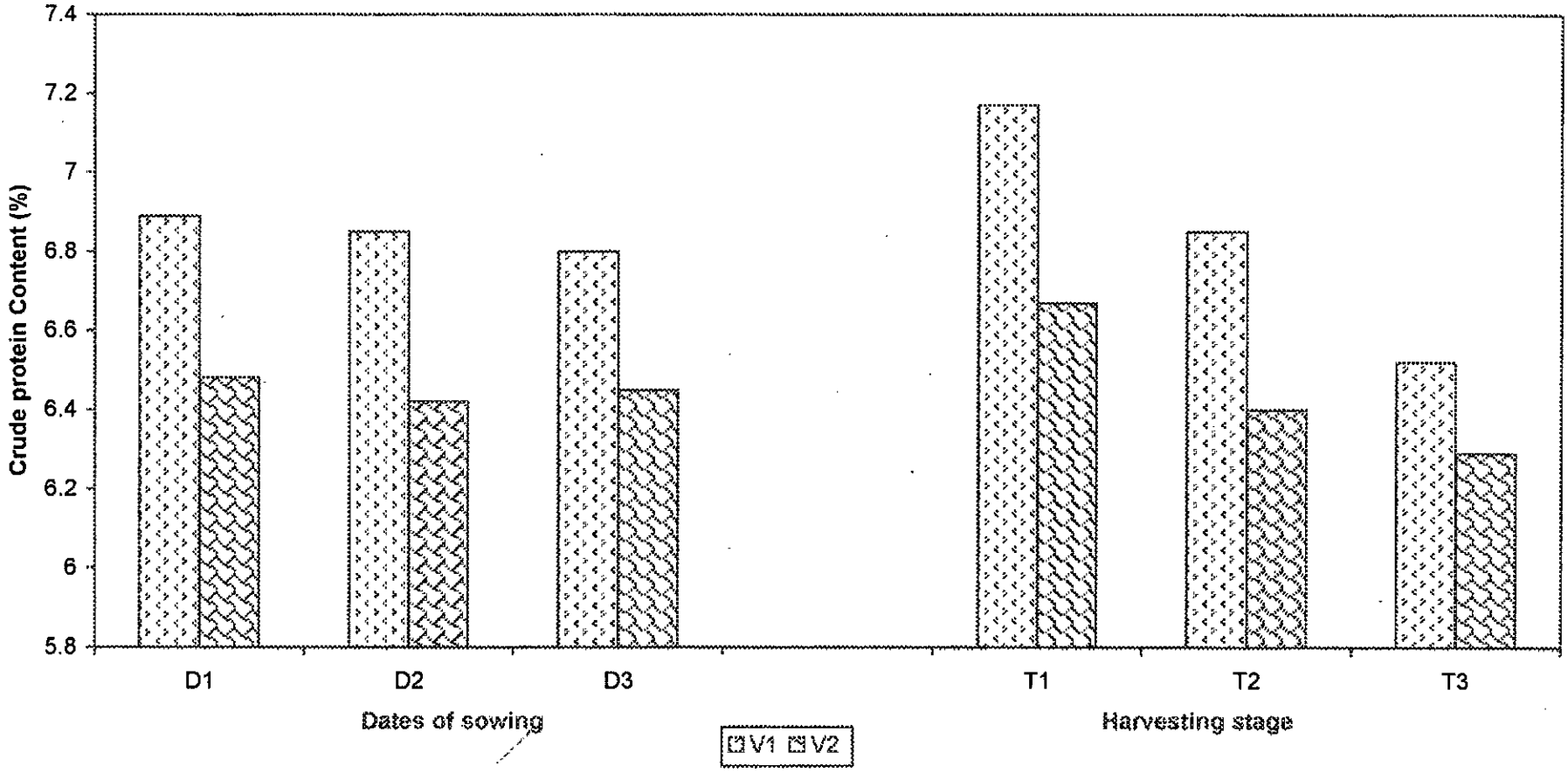


Fig. 6. Effect of sowing dates, harvesting stages and varieties on CP content

4.3.2 Crude Protein Yield

The data on crude protein yield (CPY) of maize as influenced by sowing dates, harvesting stages and varieties are given in Table 4.23 and graphically depicted in Fig.7.

(a) Effect of sowing dates

An examination of data Table 4.23 revealed that early sowing of maize crop on 30th June, D_1 synthesized significantly higher CPY (577.9 kg/ha) than delayed sowing of maize crop on 15th July (466.3 Kg/ha) and 30th July (391.5 kg/ha). The reduction in CPY due to late sowing on D_2 (15th July) and D_3 (30th July) was to the tune of 23.9 and 47.6 per cent, respectively over early sowing of maize crop on 30th June.

(b) Effect of harvesting stages

The data presented in Table 4.23 indicated that harvesting of maize crop at milking stage, T_3 produced significantly higher CPY(615.4 kg/ha) thant tasseling (333.2 kg /ha) and silking (487.1 kg/ha) stages, respectively.

(c) Effect of varieties

An appraisal of data in Table 4.23 indicated that variety African Tall, V_2 emerged first for CPY and produced

significantly higher CPY (551.5 kg/ha) than variety Gujarat Maize-2 (405.7 Kg/ha).

Table 4.23: Effect of sowing dates, harvesting stages and varieties on crude protein yield

Treatment	Crude protein yield (Kg/ha)
Dates of sowing (D)	
D_1 (30th June)	577.9
D_2 (15th July)	466.3
D_3 (30th July)	391.5
S.Em. ±	20.0
C.D. at 5 %	78.5
C.V. %	17.72
Harvesting stages (T)	
T_1 (Tasseling stage)	333.2
T_2 (Silking stage)	487.1
T_3 (Milking stage)	615.4
S.Em. ±	14.4
C.D. at 5 %	41.5
Varieties (V)	
V_1 (Gujarat Maize- 2)	405.7
V_2 (African Tall)	551.5
S.Em. ±	11.7
C.D. at 5 %	33.9
C.V. %	12.75
Significant interaction	D X V and D X T X V

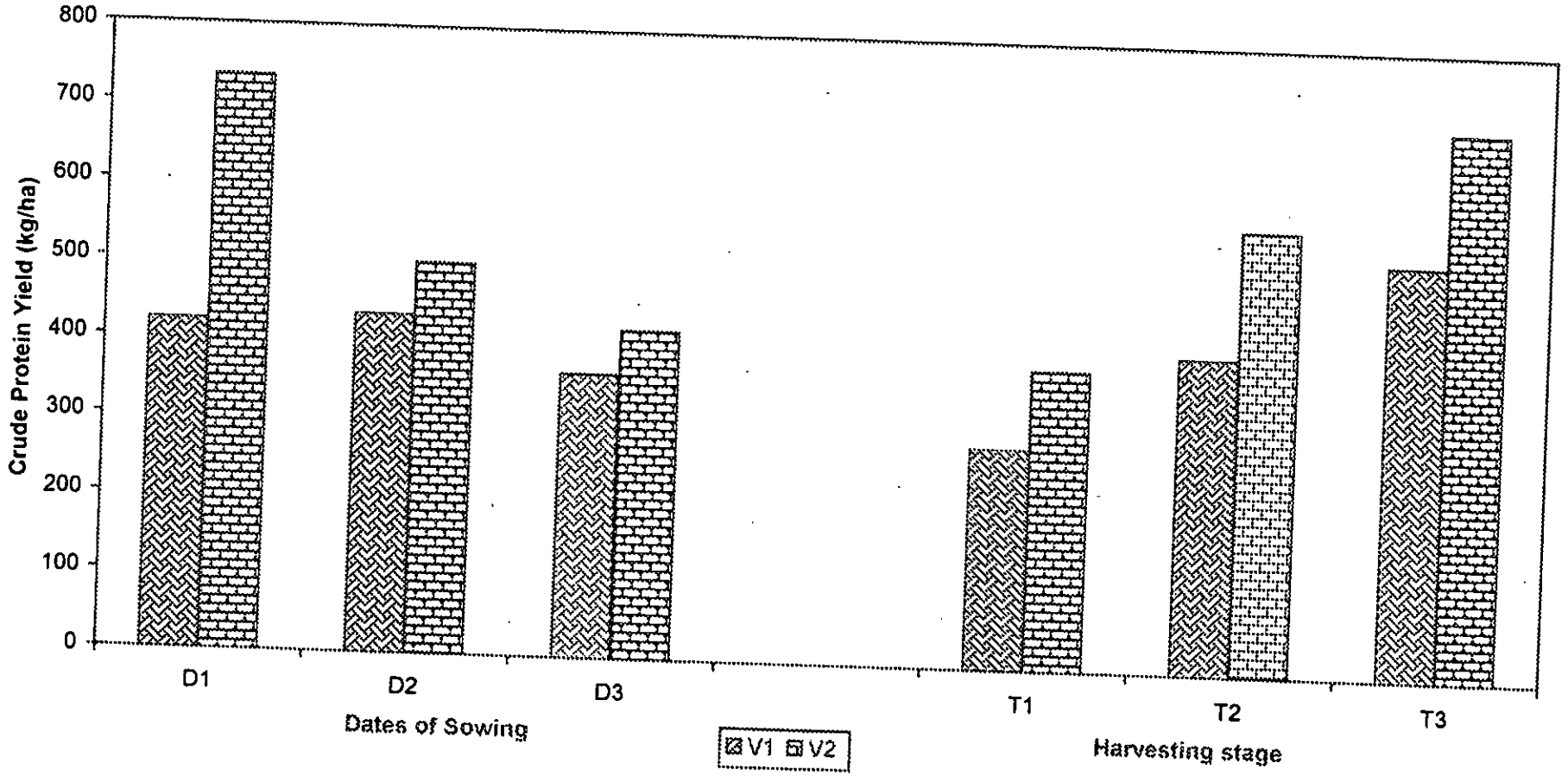


Fig. 7. Effect of sowing dates, harvesting stages and variety on CPY

(d) Effect of D x V interaction of crude protein yield

The data pertaining to significant interaction effect of DxV are given in Table 4.24.

Table 4.24: Interaction effect of D X V on crude protein yield

Dates of sowing (D)	Crude protein yield (Kg/ha)	
	Varieties (V)	
	V_1	V_2
D_1	421.3	734.5
D_2	432.5	500.1
D_3	368.2	419.8
S.Em. ±	24.9	
C.D. at 5 %	71.9	

The data in Table 4.24 indicated that the treatment combination of D_1V_2 (30th June and African Tall) recorded significantly higher CPY (734.5 kg/ha) than other treatment combinations. The sowing of maize variety GM-2 on 30th June or 15th July and African Tall sown on 15th July synthesized comparable CPY. The lowest CPY was observed by the treatment combination of D_3V_1(368.2 kg/ha).

(c) Effect of D x T x V interaction on crude protein yield

The data showed that CPY was significantly affected by sowing date, harvesting stage and varieties.

Table 4.25: Interaction effect of D X T X V on crude protein yield

Harvesting stages and varieties	Crude protein yield (kg/ha)		
	Dates of sowing		
	D_1	D_2	D_3
T_1V_1	315.97	289.55	242.01
T_1V_2	519.44	385.76	246.53
T_2V_1	424.65	425.00	365.28
T_2V_2	723.61	501.74	482.29
T_3V_1	523.26	528.99	482.29
T_3V_2	960.42	612.85	530.56
S.Em. ±	35.22		
C.D. at 5 %	101.70		

The treatment combination of $D_1T_3V_2$ showed its superiority by producing the highest CPY (960.42 kg/ha). It was found significantly superior than other treatment combinations (Table 4.25). The treatment combination of $D_1T_2V_2$ recorded the second highest CPY (723.61 kg/ha) and it has produced significantly higher CPY than other treatment combinations. The lowest CPY (242.01 kg/ha) obtained by the treatment combination of $D_3T_1V_1$.

4.3.3 Neutral detergent fibre content

The data related to NDF content as affected by various treatments are given in Table 4.26 and graphically depicted in Fig.8.

Table 4.26: Effect of sowing dates, harvesting stages and varieties on NDF content

Treatment	Neutral detergent fibre content (%)
Dates of sowing (D)	
D_1 (30th June)	61.89
D_2 (15th July)	61.49
D_3 (30th July)	61.39
S.Em. ±	0.18
C.D. at 5 %	NS
C.V. %	1.22
Harvesting stages (T)	
T_1 (Tasseling stage)	60.41
T_2 (Silking stage)	61.55
T_3 (Milking stage)	62.81
S.Em. ±	0.27
C.D. at 5 %	0.77
Varieties (V)	
V_1 (Gujarat Maize- 2)	61.05
V_2 (African Tall)	62.13
S.Em. ±	0.22
C.D. at 5 %	0.63
C.V. %	1.84

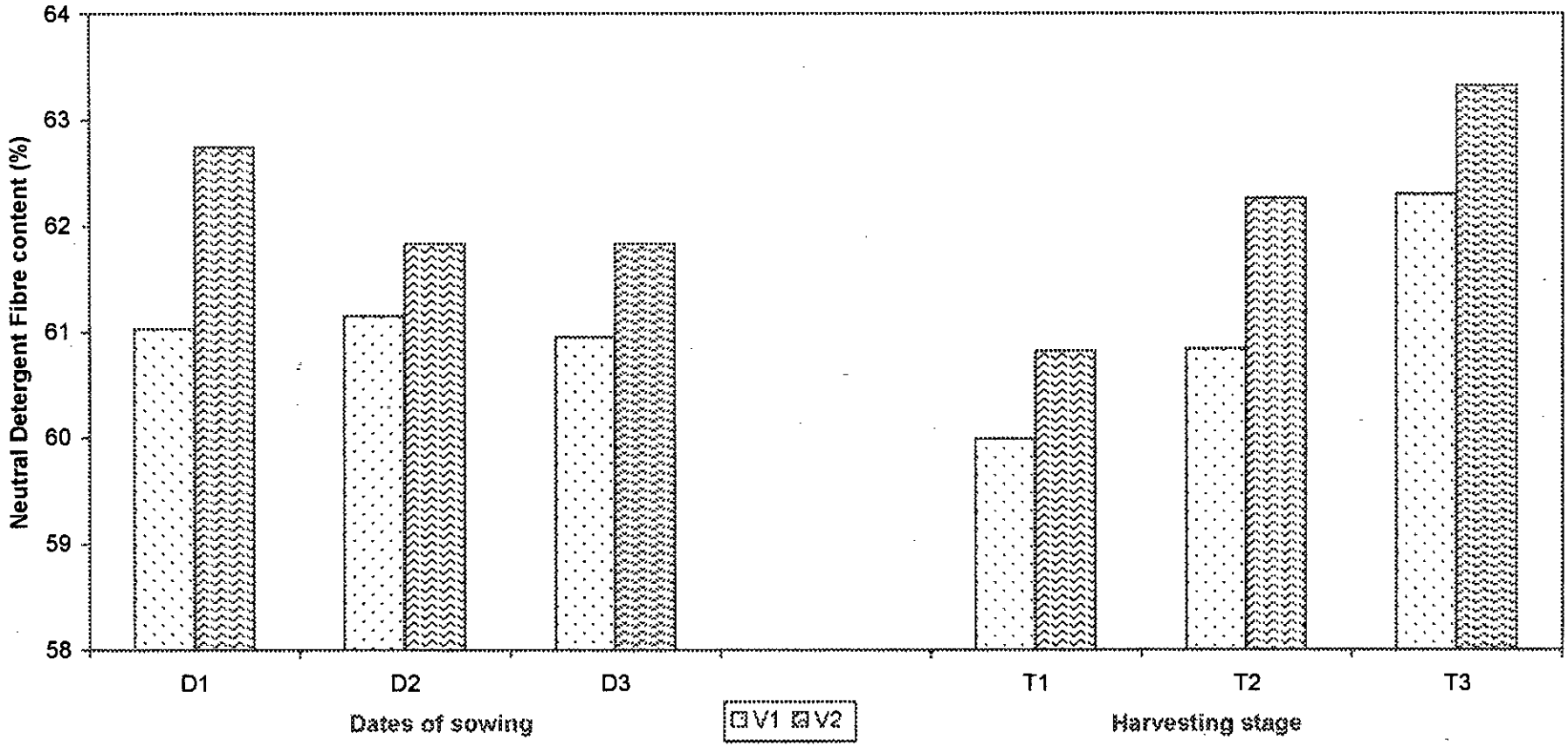


Fig. 8. Effect of sowing dates, harvesting stages and varieties on NDF content of maize

(a) Effect of harvesting stages:

The data given in Table 4.26 indicated that NDF content increased significantly with the advancing stage of maturity. The significantly lower NDF content was observed at tasseling stage (60.41 %) than silking stage (61.55%) and milking stage (62.81%).

(b) Effect of varieties

It is evident from the results that variety Gujarat Maize–2 showed significantly lower NDF content (61.05%) than variety African Tall (62.13%).

4.3.4 *In vitro* dry matter digestibility

The data related to *in vitro* dry matter digestibility (IVDMD) of maize as affected by various treatments are given in Table 4.27 and graphically depicted in Fig.9.

(a) Effect of harvesting stages

The data presented in Table 4.27 indicated that IVDMD content decreased significantly with the advancing stages of maturity. The tasseling stage, T_1 exhibited significantly higher

IVDMD content (62.88%) than silking stage (60.93%) and milking stage (58.63%).

Table 4.27: Effect of sowing dates, harvesting stages and varieties on IVDMD content of maize

Treatment	In vitro dry matter digestibility (IVDMD)content (%)
Dates of sowing (D)	
D_1 (30th June)	60.82
D_2 (15th July)	60.72
D_3 (30th July)	60.90
S.Em. ±	0.25
C.D. at 5 %	NS
C.V. %	1.77
Harvesting stages (T)	
T_1 (Tasseling stage)	62.88
T_2 (Silking stage)	60.93
T_3 (Milking stage)	58.63
S.Em. ±	0.21
C.D. at 5 %	0.59
Varieties (V)	
V_1 (Gujarat Maize- 2)	61.42
V_2 (African Tall)	60.21
S.Em. ±	0.17
C.D. at 5 %	0.48
C.V. %	1.43

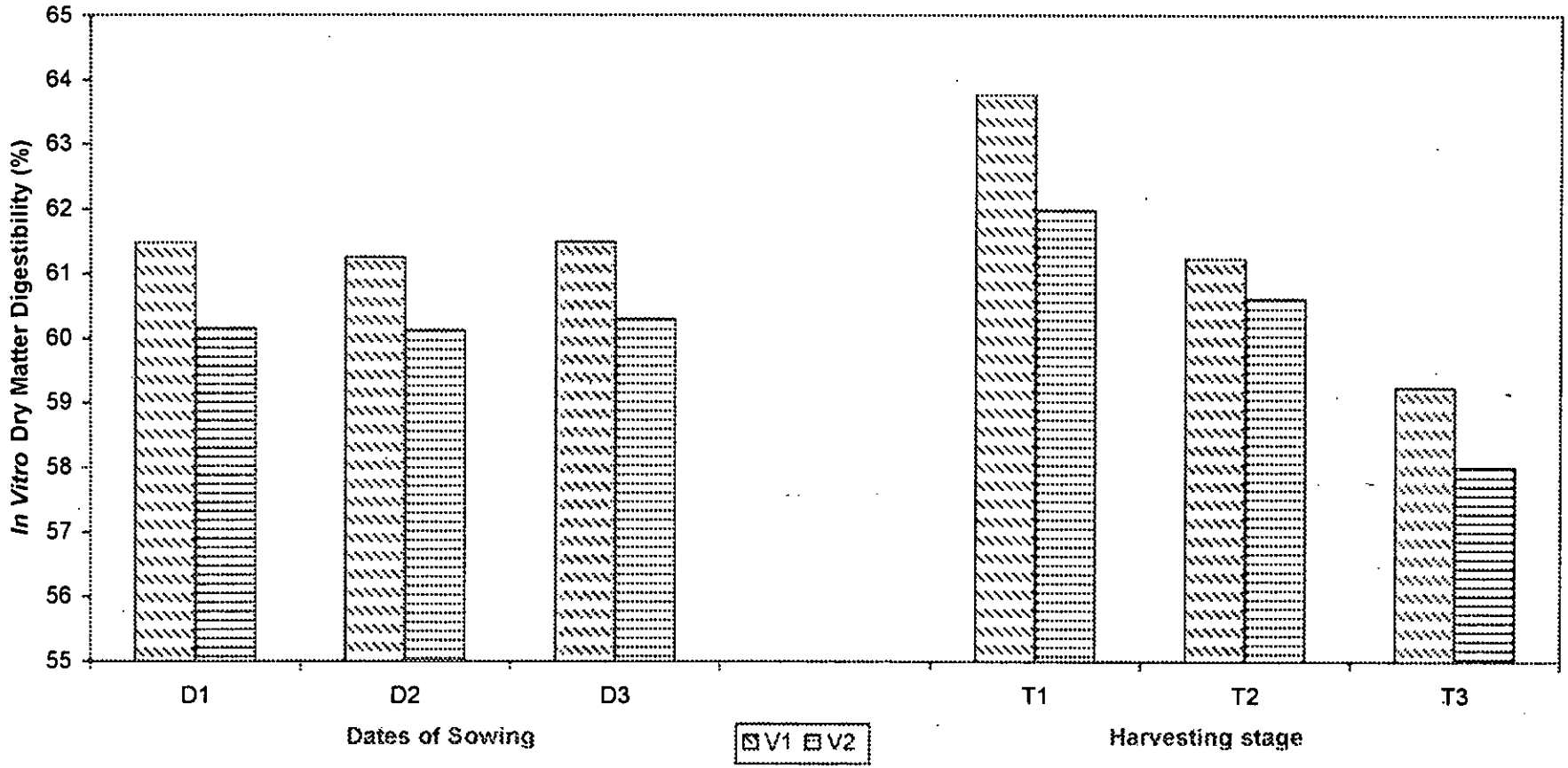


Fig. 9. Effect of sowing dates, harvesting stages and varieties on IVDMD content of maize

(b) Effect of varieties

An appraisal of data in Table 4.27 indicated that variety Gujarat Maize-2, V_1 showed significantly higher IVDMD content (61.42%) than variety African Tall, V_2 (60.21%).

4.3.5 Digestible dry matter production

The data on digestible dry matter (DDM) production as influenced by various treatments are given in Table 4.28 and graphically depicted in Fig.10.

(a) Effect of dates of sowing

An examination of data (Table 4.28) revealed that early sowing of maize crop on 30th June, D_1 produced significantly higher DDM production (52.93 q/ha) than delayed sowing of maize crop on 15th July (42.82 q/ha) and 30th July (35.35 q/ha). The magnitude of reduction in DDM production due to delayed sowing of maize crop on 15th July, D_2 and 30th July, D_3 was to the tune of 19.00 and 33.9 per cent, respectively over early sowing of maize crop on 30th June, D_1.

Table 4.28: Effect of sowing dates, harvesting stages and varieties on digestible dry matter production

Treatment	Digestible dry matter (DDM) production (q/ha)
Dates of sowing (D)	
D_1 (30th June)	52.93
D_2 (15th July)	42.82
D_3 (30th July)	35.35
S.Em. ±	2.16
C.D. at 5 %	8.50
C.V. %	20.92
Harvesting stages (T)	
T_1 (Tasseling stage)	30.91
T_2 (Silking stage)	44.07
T_3 (Milking stage)	56.26
S.Em. ±	1.22
C.D. at 5 %	3.53
Varieties (V)	
V_1 (Gujarat Maize- 2)	36.52
V_2 (African Tall)	50.97
S.Em. ±	1.00
C.D. at 5 %	2.88
C.V. %	11.88
Significant interaction	D X V

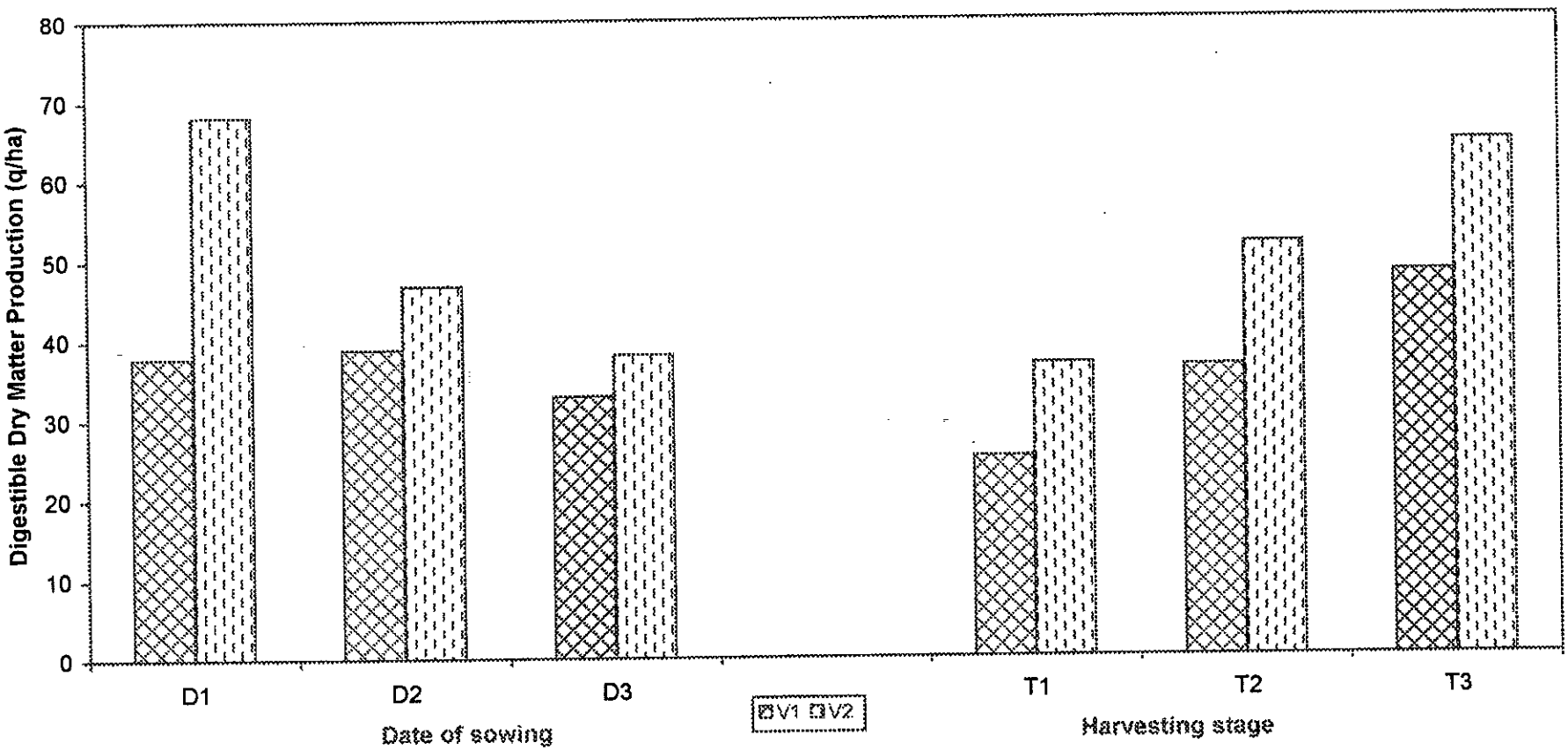


Fig. 10. Effect of sowing dates, harvesting stages and varieties on DDM production

(b) Effect of harvesting stages

The data presented in Table 4.28 indicated that milking stage, T_3 showed its superiority in producing significantly higher DDM production (56.26 q/ha) as compared to tasseling stage, T_1 (30.91 q/ha) and silking stage, T_2 (44.07 q/ha). The increase in DDM production in milking stage to the tune of 81.8 and 27.7 per cent over tasseling stage and silking stage , respectively.

(c) Effect of varieties

The variety African Tall, V_2 produced significantly higher DDM production (50.97 q/ha) over variety Gujarat Maize-2 (36.52 q/ha). The increase in DDM production in maize variety African Tall was to the tune of 39.3 per cent over GM-2.

(d) Interaction effect of D x V on DDM production

The data pertaining to significant interaction effect of D x V are presented in Table 4.29.

Table 4.29: Interaction effect of D X V on DDM production

Dates of sowing (D)	DDM production (q/ha)	
	Varieties (V)	
	V1	V2
D_1	37.82	68.04
D_2	38.85	46.79
D_3	32.90	38.10
S.Em. ±	2.12	
C.D. at 5 %	6.12	

A treatment combination of D_1V_2 distinctly differed significantly among the various combinations. It has produced significantly higher DDM production (68.04 q/ha) as compared to other treatment combinations. The D_3V_1 recorded minimum DDM production (32.90 q/ha), which was at par with treatment combination of D_1V_1 (37.82 q/ha), D_2V_1 (38.85 q/ha) and D_3V_2 (38.10 q/ha).

DISCUSSION

5. DISCUSSION

The causes and validity of significant effects presented in previous chapter are discussed in this chapter. The growth parameters, yield attributes and biochemical traits of forage maize were influenced by the dates of planting, harvesting stages and varieties. It has been attempted to establish the effect and cause relationship in light of available references and literature.

5.1 EFFECT OF DATES OF SOWING

5.1.1 Effect Of Plant Population

The plant population (T 4.7) was significantly influenced by various dates of sowing. The sowing of maize on 30th June (D_1) had the highest plant stand as compared to late sowing of maize on 30th July (D_3) but it was at par with sowing of maize on 15th July (D_2). This might be due to the facts that moderate temperature and relative humidity throughout the crop season when crop was sown on 30th June and 15th July favoured the crop growth and prevent mortality of plant. The similar type of findings were also observed by Mittal *et al.*, (1999).

5.1.2 Effect On Growth Attributes

A reference to the results in respect to periodical plant height (T.4.2), leaf length (T.4.7), leaf width (T.4.9) that all these growth characters significantly influenced by dates of sowing. The plant height, leaf length and leaf width were higher under treatment D_1 (30^{th} June) as compared to D_3 (30^{th} July) but were at par with D_2 (15^{th} July). This might be due to more favourable environment prevailing during the growth period. The late sown crop was subjected to differential environmental conditions, the early sown crop received more rainy days than that of late sown crop. The late sown crop might have faced unfavourable relative humidity and temperature conditions. The maize plant growth is increasingly subjected to stress due to high temperature and low rainfall conditions. The similar type of results were reported by Lutric (1964), Singh *et al.* (1992) and Mittal *et al.* (1997).

5.2.3 Effect On Yield And Its Attributes

A significant variation in forage yield and yield attributes occurred due to effect of sowing dates. Early planting of maize crop gave higher yield than that of late planting. The higher green forage yield with early planting and reduction with delayed

planting seems to be due to synchronization of plant growth with most congenial weather condition. Due to delayed sowing of maize crop, high temperature during maturity stage coupled with low humidity have adverse effects on green forage as well as dry matter yields of maize. The increase in temperature and low rainfall shorten the crop growth period, particularly the maturity period, thereby causing dramatic negative effects on yield. These results are in close conformity with the results obtained by Pathak *et al.*, (1971), Farrell (1975), Prasad and Joshi (1988), Rosenzwey *et al.*, (1993) and Khola *et al.*, (1999).

5.1.4 Effect On Biochemical Traits

The crude protein, neutral detergent fibre content and *in vitro* dry matter digestibility were not differed significantly by date of sowing, but crude protein yield and digestible dry matter production were significantly higher with early sowing of maize on D_1(30th June) as compared to late sowing of maize on D_2 and D_3(15th July and 30th July). This may be due to higher dry matter yield and fairly higher CP content obtained with treatment D_1 (30th June). The similar results were also obtained by Kimda *et al.*, (1988)., Olness *et al.*, (1990) and Mittal *et al.*, (1999).

5.2 EFFECT OF HARVESTING STAGES

5.2.1 Effect On Plant Population

The uniform plant stand was recorded in plots harvested at tasseling (T_1), silking(T_2) and milking (T_3) stages which may be probably due to uniform seed rate used in all the plots.

5.2.2 Effect On Growth Attributes

Plant height (T.4.2), leaf length (T.4.7), leaf width (T.4.9) and stem thickness recorded at milking stage (T_3) were significantly higher than those recorded at tasseling stage (T_1) and silking stage (T_2).

Increase in growth attributes up to milking stage may be probably due to continuous vegetative growth in maize crop up to milking stage. This finding is corroborated with the result of Tiwana *et al.*, (1983) and Agath *et al.*, (1997), they reported continuous vegetative growth in maize crop up to milking stage.

5.2.3 Effect On Yield And Its Attributes

The total number of leaves (T.4.12), green forage yield (T.4.15), dry matter content (T.4.17) and dry matter yield

(T.4.19) recorded at milking stage (T_2) were significantly higher than recorded at tasseling stage (T_1) and silking stage (T_2). Milking stage recorded 52.2 & 27.2 per cent higher green forage yield and 95.1 and 32.8 per cent higher dry matter yield over that recorded at tasseling stage (T_1) and silking stage (T_2), respectively. The higher forage yield obtained at milking stage could be because of the fact that vegetative growth in maize crop normally take place up to milking stage and therefore the nutrient absorbed by maize plants get utilized for the maturity and grain formation. Present finding is supported with the results of the Desai and Washko (1982) and Tiwana *et al.*, (1983). Increased dry matter yield with delayed harvesting stages of maize crop have also been reported by Patel *et al.*, (1990) and Agath *et al.*, (1997).

5.2.4 Effect On Biochemical Traits

The crude protein content of maize (T.4.22) plant decreased with delayed in harvesting stage from tasseling (T_1) to milking (T_3) but crude protein yield (T.4.23) increased with delayed harvesting (T_3). Decrease in crude protein content in

maize plants with advance in maturity may be due to the fact that protein is a most important constituent of protoplasm. The consumption of protein increased with rapid cell division and multiplication, resulting to plant growth. Thus protein contents become less and less traceable in herbage. These findings are in accordance with those reported by Mannitas *et al.*, (1976), Suresh Kumar *et al.* (1979), Desai and Washko (1982) and Agath *et al.*, (1997).

The increase in crude protein yield upto milking stage most probably due to higher dry matter yield obtained at milking stage. These findings are in accordance with Chauhan *et al.*, (1979), and Patel *et al.*, (1990).

The neutral detergent fibre content in maize plant was increased with delaying harvesting but IVDMD content in maize plants decreased with delayed harvesting from tasseling to milking stage. The increase in neutral detergent fibre content of maize with advancing maturity which may be due to increase in dry matter yield with delaying in maturity. The results are in accordance with the results of Mannikar *et al.*, (1976), Suresh kumar *et al.*, (1979), Tolera *et al.*, (1998). The decrease in IVDMD content with delaying in harvesting stage may be due to

lignification of the cell wall and resulted in increase in fibre content (NDF, CF, ADF etc.,) resulted in decreasing of IVDMD content. The DDM production was highest at milking stage. It is attributed to significantly higher DMY in milking stage as compared to tasseling and silking stages. These findings are in accordance with Desai and Washko (1982) and Firdous *et al.*, (1998).

5.3 EFFECT OF VARIETIES

5.3.1 Effect On Growth Attributes

The fodder maize variety African Tall (V_2) has significantly greater plant height (T.4.2), leaf length (T.4.7), leaf width (T.4.9) and stem thickness (T.4.4) as compared to variety Gujarat Maize-2 (V_1). This may be due to its vigour, provided large canopy and vigorous growth, which contributes towards higher growth of the plants of African Tall as compared to variety Gujarat Maize-2. It might also be due to varying genetic potentiality of the two varieties. The plant height, and LAI were greater in cultivars with a longer growth period has also been reported by Lourenco and Caroleno (1990), Patil (1992), Jadhoa *et al.*, (1995) and Mittal *et al.*, (1999).

5.3.2 Effect On Yield And Yield Attributes

The total number of leaves, green forage as well as dry matter yield and dry matter content were recorded significantly higher in variety African Tall (V_2) over variety Gujarat Maize-2 (V_1). Remarkable improvement in yield component under variety African Tall over that of Gujarat Maize-2 seems to be due to long duration of African Tall (90 days) which resulted in greater plant vigour and response to fertilizers which in turn resulted in higher total number of leaves, green and dry matter yield. Similar findings were reported by Prasad and Singh (1988), Patil(1992), Jadhoa *et al.*,(1995) and Mittal *et al.*,(1999).

5.3.3 Effect On Biometrical Traits

The significantly higher crude protein content was observed in variety Gujarat Maize-2 but the significantly higher crude protein yield was synthesized by the variety African Tall. The lower CP content in African Tall might be due to dilution effect as it has significantly higher plant height (218.20 cm) as compared to GM-2 (189.64cm). The similar type of variation in CP content in maize crop has also been reported by Pal and

Panwar (1975) & Mittal *et al.* (1999). The higher crude protein yield may be due to significantly higher dry matter yield, which in turn produced significantly higher crude protein yield. Similar findings were reported by Pal and Panwar (1975), Patel *et al* (1990) and Jadhoa *et al.* (1995).

The NDF content of maize at harvesting stage was significantly influenced due to varieties. The variety African Tall recorded higher NDF content (62.13%) than Gujarat Maize-2 (61.05%). It might be due to longer duration required for tasseling, silking and milking stage resulted in increase in fibre content i.e., NDF content.

The IVDMD content was higher in GM-2. It might be due to lower NDF content in GM-2 as compared to African Tall. It is evident from negative significant correlation (r = - 0.4861**) between NDF and IVDMD content. The such type of variations in different varieties in NDF and IVDMD contents were also reported by Firdous *et al.* (1996).

The higher DDM production was observed with maize variety African Tall than GM-2. This might be due to significantly higher DMY produced by the variety African Tall (85.39 q/ha) than GM-2 (60.06 q/ha) and also narrow differences

in IVDMD content (African Tall, 60.21 % and GM –2 , 61.42 %) in both these varieties.

5.4 INTERACTION EFFECT

5.4.1 Effect Of Interaction Of D X V

The interaction effect of D X V with respect to green forage yield, number of leaves, plant height, leaf length, leaf width, stem thickness, dry matter content, dry matter yield and crude protein yield were significant.

The treatment combination of D_1V_2 recorded significantly higher plant height (249.70 cm) or higher total number of leaves per plant (15.02) as compared to other treatment combinations.

The treatment combination of D_1V_2 also having significantly higher leaf length (103.20 cm), leaf width (7.24 cm) and stem thickness (1.42 cm) as compared to other treatment combinations.

The significantly higher GFY (470.4 q/ha), DM content (23.83%) and DMY (114.16 q/ha) were obtained with this treatment combination, while the lowest GFY, DM content and DMY obtained with the treatment combination of D_3V_1.

The treatment combination of D_1V_2 synthesized significantly higher CPY (734.5 kg/ha) and produced significantly higher DDM production (68.04 q/ha) over other treatment combinations.

5.4.2 Effect Of Interaction Of D X T

The interaction effect of D x T found significant with respect to total number of leaves and leaf width. The treatment combination of D_1T_3 recorded significantly higher leaf width (7.25 cm) and total number of leaves (15.02) over other treatment combinations.

5.4.3 Effect Of Interaction Of T X V

The stem thickness was found significant in respect to T x V interaction. The treatment combination of T_3V_2 recorded significantly greater thickness, while T_1V_1 recorded minimum stem thickness (1.22 cm).

5.4.4 Effect Of D X T X V Interaction

The dry matter and crude protein yields were significantly influenced by D x T x V interaction. The treatment

combination of $D_1T_3V_2$ produced significantly higher DMY (152.08 q/ha) and CPY (960.42 kg/ha) over all other treatment combinations, while the treatment combination of $D_3T_1V_1$ recorded significantly the lowest DMY (34.13 q/ha) and CPY (242.01 kg/ha).

SUMMARY & CONCLUSION

CONCLUSIONS

Based on the results of one year field experimentation, it may be concluded that under middle Gujarat Agro-climatic Zone III condition, forage maize crop sown on 30th June using variety African Tall and harvesting the crop at milking stage produced maximum green as well as dry matter yield and also gave significantly higher crude protein yield, CP content and DDM production.

However, these results are only indicative, based on one year experimentation and require further testing to establish the validity of above conclusion.

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APPENDICES

APPENDIX-I

Analysis of variance, for plant population per plot at harvest

Source of variance	DF	Mean sum of square
Replication	2	5.111
D	2	1874.11*
Error (A)	4	34.639
T	2	46.667
V	1	13.463
D x T	4	39.028
D x V	2	51.741
T x V	2	178.407
D x T x V	4	60.602
Error (B)	30	171.663

*Significant at 5% level

APPENDIX –II

Analysis of variance for growth characters

Source of variance	DF	Mean Sum of Square			
		Plant height (cm)	Stem thickness (cm)	Leaf length (cm)	Leaf width (cm)
Replication	2	20.040	0.001	17.061	0.387
D	2	5178.094*	0.013	611.438*	2.061*
Error A	4	138.844	0.003	17.567	0.158
T	2	18361.320*	0.190*	667.026*	4.810*
V	1	11005.780*	0.022	5761.792*	3.840*
D x T	4	116.524	0.002	2.818	0.232*
D x V	2	3822.443*	0.061*	210.391*	0.638*
T x V	2	62.678	0.041*	42.086	0.192
D x T x V	4	52.599	0.002	14.045	0.133
Error B	30	63.662	0.002	16.403	0.077

*Significant at 5% level

APPENDIX –III

Analysis of variance for yield and yield attributes

Source of variance	DF	Mean sum of square			
		No. of leaves	GFY yield (q/ha)	Dry matter content (%)	DMY (q/ha)
Replication	2	1.183	1697.4750	1.656	180.641
D	2	20.615*	44626.94*	33.787	3892.00*
Error A	4	0.850	2384.6030	10.172	245.632
R	2	44.222*	92704.54*	125.431*	9932.93*
V	1	42.313*	101725.30*	33.044*	8654.409*
D x T	4	0.805*	808.2993	0.942	83.589
D x V	2	11.140*	26522.38*	18.237*	2429.563*
T x V	2	0.223	2527.2850	3.695	116.066
D x T x V	4	0.166	842.4620	4.792	239.980
Error B	30	0.266	1050.0080	2.159	77.7743

* Significant at 5% level

APPENDIX – IV

Analysis of variance for quality characteristics

Source of variance	DF	Mean sum of square			
		CP content (%)	CPY kg/ha	NDF (%)	IVDMD (%)
Replication	2	0.022	3378.227	0.493	0.898
D	2	0.020	158376.900*	1.230	0.116
Error A	4	0.005	7188.073	0.568	1.164
T	2	1.200*	359284.300*	26.016*	81.724*
V	1	2.112*	286954.600*	15.923*	19.618*
D x T	4	0.003	3889.524	0.206	1.126
D x V	2	0.009	94713.930*	1.356	0.101
T x V	2	0.097	6720.252	0.414	1.552
D x T x V	4	0.002	10276.410*	0.252	0.150
Error B	30	0.030	3720.860	1.285	0.759

* Significant at 5% level

APPENDIX –V

Analysis of variance for DDM production (q/ha)

Source of variance	DF	Mean sum of square DDM (q/ha)
Replication	2	72.587
D	2	1378.878*
Error A	4	84.384
T	2	2893.921*
V	1	28196.750*
D x T	4	17.993
D x V	2	847.564*
T x V	2	26.974
D x T x V	4	72.582
Error B	30	27.017

*significant at 5% level

APPENDIX – VI

LIST OF ABBREVIATIONS

@	At the rate
AV.	Average
°C	Degree centrigrade
C.D.	Critical difference
cm	Centimetre
CP	Crude protein
CPY	Crude protein yield
cv.	Cultivar
C.V.	Co-efficient of variation
DAS	Days after sowing
DDM	Digestible dry matter
DMC	Dry matter content
DMY	Drymatter yield
EP	Evaporation
et al.,	et allii, and others
Fig.	Figure
g	Gram
GFY	Green Forage yield
GM-2	Gujarat Maize-2
ha	Hectare
i.e.,	That is

IVDMD	In vitro dry matter digestibility.
Kg	Kilogram
m	Metre
Max.	Maximum
Min.	Minimum
NDF	Neutral detergent fibre
No.	Number
RF	Rainfall
RH	Relative humidity
S.Em. ±	Standard error of mean
Var.	Variety
Viz.,	Namely
/	Per
%	Per cent