CHAPTER-V
DISCUSSION

An attempt to review the results reported in Chapter-IV pertaining to the investigation entitled “Identification of Suitable Date of sowing and Variety of Wheat (Triticum aestivum L.) for South Saurashtra, Gujarat under Changing Climatic Conditions” showed many significant variations among different treatments and an attempt has been made to discuss the variations observed in growth attributes, yield attributes, yield, physiological parameters, water use, quality, nutrient content and their uptake by grain and straw, nutrient status in soil after harvest of wheat crop, and economics. It has also been attempted to establish “cause and effect” relationship based on present investigation duly supported by available evidences and relevant findings. The entire discussion has been partitioned into following major parts, viz.-

5.1 Weather and growth

5.2 Effect of dates of sowing

5.3 Effect of varieties

5.4 Interaction effect of dates of sowing and varieties

5.5 Economics

5.1 WEATHER AND GROWTH

In agriculture, the crop response is largely governed by soil, and certain weather parameters during crop growth and developmental period. The meteorological data furnished in (Table 3.1 and Fig. 3.1) revealed that all the meteorological parameters were congenial for the satisfactory growth and development of wheat during rabi season of 2015-16. The crop was kept weed free by pre-emergence application of pendimethalin 30 % EC and one hand weeding at 30 DAS. There was no serious incidence of pests and diseases during crop period. Whatever variations observed in the present investigation are, therefore, attributed to different treatments exercised in this experiment.
5.2 Effect of dates of sowing

5.2.1 Growth parameters

Germination percentage (Table 4.1 and Fig. 4.1) and initial plant population per square meter (Table 4.2 and Fig. 4.2) was found significantly maximum with sowing on 15th November which was at par with sowing on 25th November. Low germination percentage and plant population with sowing on 05th November and 05th December could be attributed to unfavorable temperature regimes. The optimum temperature for germination of wheat is from 12 ºC to 25 ºC. These findings are closely associated with Sharma and Choker (1989) and Islam et al. (2013). Plant height at 30, 60 DAS and at harvest was significantly higher with sowing on 15th November, being at par with 05th November and 25th November sowing (Table 4.3 and Fig. 4.3). Dry matter accumulation at 30, 60 DAS and harvest was significantly maximum with sowing on 15th November. Dry matter accumulation at 30 and 60 DAS was statistically at par with sowing on 05th November and 25th November, while dry matter accumulation at harvest was at par with sowing on 25th November (Table 4.4 and Fig. 4.4). Crop growth rate from 30 to 60 DAS was found significantly highest with sowing on 15th November which was statistically at par with 25th November sowing. From 60 DAS to harvest crop growth rate was observed statistically highest with sowing on 05th December (Table 4.5 and Fig. 4.5). Significantly lower plant height and dry matter accumulation at 30, 60 DAS and at harvest with sowing on 05th December could be due to lower temperature during vegetative stage. These findings supported the results of Mishra et al. (2003), Sanghera and Thind (2014), and Singh and Dwivedi (2015).

5.2.2 Growing Degree Days, Helio Thermal Unit, Photo Thermal Unit and Heat Use Efficiency

Maximum Growing Degree Days at different phenological stages viz., emergence, CRI, tillering, jointing, anthesis, milking, soft dough, and physiological maturity was recorded with sowing on 05th November (Table 4.7 and Fig. 4.6). The higher Growing Degree Days observed with sowing on 05th November might be attributed to higher prevailing temperatures when crop is sown earlier than the optimum sowing time. These findings are in close conformity with those of Nainwal and Singh (2000).

Helio Thermal Unit was found highest at emergence with sowing on 15th November and at CRI, tillering, anthesis and physiological maturity with sowing on
05th November. While at jointing and milking stage Helio Thermal Unit was observed highest with sowing on 25th November (Table 4.8 and Fig. 4.7). Total Growing Degree Days, Helio Thermal Unit, and Photo Thermal Unit from sowing to maturity was maximum with sowing on 05th November (Table 4.9 and Fig. 4.8 and 4.10) which is due to higher temperature and length of the day, and longer duration taken by crop to mature with early sowing. Heat use efficiency from sowing to maturity was significantly higher with sowing on 15th November (Table 4.9 and Fig. 4.9 and 4.11). This may be attributed to higher crop yield under relatively optimum temperature conditions and lower total Growing Degree Days when sown on 15th November. Similar results have also been reported by Hariram and Mavi (2012).

5.2.3. Root Studies

Root dry weight (Table 4.11 and Fig. 4.12), root length (Table 4.12 and Fig. 4.13) and root volume (Table 4.13 and Fig. 4.14) at 30, 60 DAS and at harvest was significantly higher with sowing on 15th November, being at par with 25th November sowing. The significantly lower root dry weight, root length, and root volume in wheat at 30, 60 DAS and at harvest with sowing on 05th November and 05th December may be attributed to unfavorable temperature conditions. These results support the findings of Alam et al. (2013).

5.2.4 Canopy temperature and soil temperature

Canopy temperature at 60 DAS was observed significantly highest with 05th November sowing (Table 4.14 and fig. 4.15). Similarly, soil temperature at 7.5 and 15 cm depth at emergence was found significantly higher with sowing on 05th November compared to other dates of sowing. This could be attributed to higher ambient temperature with early sowing. Similar results were also reported by Saikia (2011).

5.2.5 Phenological stages

Different phenological stages were significantly affected by dates of sowing except, emergence. Occurrence of CRI, tillering, jointing, anthesis, milking, soft dough, and physiological maturity took maximum time with sowing on 05th November. The occurrence of soft dough and physiological maturity was statistically at par with sowing at 05th November and 15th November (Table 4.15 and Fig. 4.17). The high temperature observed with early sowing i.e. 05th November adversely affected growth and development of plants, particularly during vegetative stages. Similar results have also been reported by Chakrabarti et al. (2011).
5.2.6 Yield attributes

Significantly, maximum number of effective tillers/plant (Table 4.16 and Fig. 4.18), number of effective tillers/meter, and total tillers/meter (Table 4.16 and Fig. 4.19) were recorded with sowing on 15th November, being at par with 25th November sowing. The unfavorable temperature as observed with sowing on 05th November and 05th December had deleterious effects on tillering capacity of plants thereby, reducing number of effective tillers per plant, and total and effective tillers per meter. Kaneria (1983), and Sharma and Choker (1989) also reported similar findings. Length of spike (Table 4.16 and Fig. 4.20), number of grains/spike (Table 4.16 and Fig. 4.21), weight of spike (Table 4.17 and Fig. 4.22), and test weight (Table 4.17 and Fig. 4.23) was significantly maximum with sowing on 15th November and was at par with 25th November sowing. The availability of relatively optimum temperature conditions with sowing on 15th November and 25th November resulted in better growth and development of plants leading to better performance in terms of yield attributes as compared to crop sown on 05th November and 05th December. These results confirm the findings of Girothia et al. (1987) and Khokhar et al. (2010). Grain yield (Table 4.17 and Fig. 4.24), straw yield (Table 4.17 and Fig. 4.25) and biological yield (Table 4.17 and Fig. 4.26) was significantly higher with sowing on 15th November, which was statistically at par with 25th November sowing. The higher values of yield attributes with sowing on 15th November and 25th November due to favourable temperature regimes ultimately led to increased crop yield as compared to early and late sown crops. Harvest index was not significantly affected by different dates of sowing (Table 4.18 and Fig.27). The higher temperature during germination and early vegetative phases, as simulated by early sowing on 05th November, adversely affected tillering capacity of plants as well as yield attributes like length of spike, grains/spike, and test weight which ultimately resulted into lower yield of wheat as compared to sowing under favorable temperature regimes. Similarly, higher temperature at grain filling, as simulated by late planting i.e. 05th December, led to forced maturity, thereby, reducing the grain yield. Besides, late planting reduced the vegetative period. Moreover, significantly lower plant population with sowing on 05th November and 05th December also resulted into lower crop yield. Dhaka et al. (2006), Abdullah et al. (2007), Qasin et al. (2008), Tahir et al. (2009), Ali et al. (2010), Singh et al. (2011) and Jat et al. (2013) also reported similar findings.
5.3.7 Water studies

The number of irrigations applied were significantly higher with 05\textsuperscript{th} November sowing (Table 4.21 and Fig. 4.28). While lowest number of irrigations were given with sowing on 05\textsuperscript{th} December. The higher ambient temperature encountered with early sowing caused faster depletion of soil moisture due to high evapotranspiration losses. Similar results have been reported by Saikia (2011). Water use efficiency was significantly higher with sowing on 15\textsuperscript{th} November, being at par with 25\textsuperscript{th} November sowing (Table 4.21 and Fig. 4.29). This may be due to higher grain yield and lower amount of irrigation water applied with sowing on 15\textsuperscript{th} November. Similar results have been reported by Kour \textit{et al.} (2013).

4.2.8 Quality parameters

Significantly, maximum protein content in grain was recorded with sowing on 15\textsuperscript{th} November which was statistically at par with 05\textsuperscript{th} November sowing (Table 4.23 and Fig. 4.30). Delayed sowing leads to heat stress at grain filling stage which results in forced maturity and shriveled grains with poor quality and low protein content, which is correlated with low nitrogen content in such grains. These results support findings of Kamani and Singh (2013) and Hussain \textit{et al.}, (2015).

Nitrogen content in grain and straw was significantly higher with 15\textsuperscript{th} November sowing and was at par with 05\textsuperscript{th} November and 25\textsuperscript{th} November sowing (Table 4.24 and Fig. 4.31). Phosphorus content in grain was recorded significantly highest with sowing on 15\textsuperscript{th} November, being at par with 05\textsuperscript{th} November sowing (Table 4.25 and Fig. 4.32) while phosphorus content in straw was found to be non-significant (Table 4.25). Potassium content in grain and straw was significantly higher with sowing on 15\textsuperscript{th} November which was at par with 05\textsuperscript{th} November sowing (Table 4.26 and Fig. 4.33). In general, the higher N, P and K content in grain and straw with sowing on 15\textsuperscript{th} November could be due to favorable temperature conditions leading to better growth and development of plants. The present findings are in close agreement with the results found by Kajla \textit{et al.} (2015).

4.2.9 N, P and K uptake

Nitrogen uptake by grain and straw as well as total nitrogen uptake was recorded significantly highest with sowing on 15\textsuperscript{th} November which remained at par with 05\textsuperscript{th} November sowing (Table 4.27 and Fig. 4.34). Phosphorus uptake by grain and total phosphorus uptake was significantly higher with sowing on 15\textsuperscript{th} November (Table 4.28 and Fig. 4.36). However, phosphorus uptake by straw was not
Discussion

significantly affected by different dates of sowing (Table 4.28). Potassium uptake by grain and straw, and total potassium uptake was found statistically higher with sowing on 15th November (Table 4.29 and Fig. 4.38). In general, the significantly higher uptake of N, P, and K by grain and straw as well as their total uptake is due to higher yield and N, P, and K content in grain and straw with sowing on 15th November. The present findings are in close agreement with the results found by Dhaka et al. (2006).

4.2.10 Soil analysis

The N, P₂O₅ and K₂O content in soil after harvest was significantly affected by different dates of sowing. Significantly, maximum available N, P₂O₅ and K₂O in soil after harvest of wheat was observed with sowing on 05th December (Table 4.30 and Fig. 4.40, 4.41 and 4.42). This could be attributed to low nutrient uptake by plants due to poor growth and development of plants and lower productivity due to unfavorable temperature conditions when sown on 05th December (Deshmukh et al., 2015 and Mumtaz et al., 2015)

5.3 Effect of varieties

5.3.1 Growth parameters

Germination percentage (Table 4.1 and Fig. 4.1) and plant population per square meter (Table 4.2 and Fig. 4.2) was not significantly affected by different varieties (Table 4.1 and Fig. 4.1). Plant height at 30, 60 DAS and at harvest was recorded statistically highest in GW 366 which was at par with GW 322 (Table 4.3 and Fig. 4.3). While dry matter accumulation at 30 and 60 DAS and harvest was significantly higher in GW 366, being at par with GW 322 at 30 and 60 DAS (Table 4.4 and Fig. 4.4). Crop growth rate from 30 to 60 DAS and 60 DAS to harvest was significantly higher in GW 366, being at par with GW 322 (Table 4.5 and Fig. 4.5 and 4.6). The better performance of GW 366 in terms of higher values of growth attributes may be attributed to its better genetic potential.

Growing Degree Days (Table 4.9 and Fig. 4.8), Helio Thermal Unit (Table 4.9 and Fig.4.9), Photo Thermal Unit (Table 4.9 and Fig.4.10) from sowing to maturity was not affected by different varieties. Significantly maximum heat use efficiency was recorded with GW 366 (Table 4.9 and Fig.4.11). Root dry weight (Table 4.11 and Fig. 4.12), root length (Table 4.12 and Fig. 4.13) and root volume (Table 4.13 and Fig. 4.14) at 30, 60 DAS and at harvest was significantly higher with GW 366. Canopy temperature at 60 DAS (Table 4.14 and Fig. 4.15) and soil temperature at 7.5 and 15 cm depth (Table 4.14 and Fig.4.16) was also not significantly affected by different
varieties. The occurrence of phenological stages in different varieties differed significantly except, emergence. The occurrence of CRI, tillering, jointing, anthesis, milking, soft dough, and physiological maturity took significantly maximum days in GW 366. These results confirm the findings of Patel et al. (2012) and Mishra et al. (2015).

5.3.2 Yield attributes

Number of effective tillers/plant, effective tillers/meter and total tillers/meter was significantly higher in GW 366 (Table 4.16 and Fig. 4.18). Significantly, maximum length of spike, number of grains/spike, weight of spike and test weight was recorded with GW 366 (Table 4.17 and Fig. 4.20, 4.21, 4.22 and 4.23). The higher genetic potential of GW 366 resulted into better yield attributes as compared to GW 322 and GW 173. Grain yield, straw yield and biological yield was recorded significantly higher with GW 366 (Table 4.18 and Fig. 4.24, 4.25 and 4.26). The better growth and yield attributes in GW 366 resulted into higher yield as compared to GW 322 and GW 173. Harvest index was found significantly higher in GW 366, being at par with GW 322 (Table 4.18 and Fig. 4.27). These results are in accordance to earlier findings of Patel et al. (2012), Alam et al. (2013), Lak et al. (2013), Kota et al. (2013), Fayed et al. (2014), Rahmat et al. (2014), Silva et al. (2014), Suleiman et al. (2014) and Deshmukh et al. (2015).

5.3.3 Water studies

The number of irrigations applied were not significantly affected by different varieties (Table 4.21 and Fig. 4.28). Water use efficiency was significantly higher with GW 366 and was at par with GW 322 (Table 4.21 and Fig. 4.29). This is attributed to higher yield obtained with GW 366 and GW 322 as compared to GW 173 (Patel et al. 2012 and Mishra et al. 2015).

5.3.4 Quality parameters

Protein content in grain was significantly higher in GW 366 and was at par with GW 322 (Table 4.23 and Fig. 4.30). Nitrogen content in grain and straw was significantly higher in GW 366 and remained at par with GW 322 (Table 4.24 and Fig. 4.31). Phosphorus content in grain was significantly higher in GW 366 (Table 4.25 and Fig. 4.32) but phosphorus content in straw was found to be non-significant (Table 4.25). Potassium content in grain and straw was significantly higher in GW 366 and was at par with GW 322 in straw (Table 4.26 and Fig. 4.33).
5.3.5 N, P and K uptake

Significantly, maximum nitrogen uptake by grain and straw as well as total N uptake was recorded in GW 366 (Table 4.27 and Fig. 4.34). Phosphorus uptake by grain and total P uptake was significantly higher in GW 366 (Table 4.28 and Fig. 4.36) but, phosphorus uptake by straw was found to be non-significant (Table 4.28). Similarly, potassium uptake by grain and straw, and total K uptake was recorded significantly higher in GW 366 (Table 4.29 and Fig. 4.38). These results confirm the findings of Patel et al. (1999) and Amin et al. (2011).

5.3.6 Soil analysis

The N, P₂O₅ and K₂O content in soil after harvest was significantly affected by different varieties. Significantly, maximum available N, P₂O₅ and K₂O in soil after harvest in wheat was observed with GW 173. Soil P₂O₅ and K₂O was statistically at par in GW 173 and GW 322 (Table 4.30 and Fig. 4.40, 4.41 and 4.42). The higher N, P₂O₅ and K₂O content in soil after harvest with GW 173 could be attributed to lower productivity and consequent lower uptake as compared to GW 366. These results confirm the findings of Patel et al. (2012), Mishra et al. (2015) and Deshmukh et al. (2015).

5.4 Interaction effect between dates of sowing and varieties

The interaction effects of dates of sowing and varieties were found significant on crop growth rate from 30 to 60 DAS, heat use efficiency, grain yield, biological yield and water use efficiency. The sowing of GW 366 on 15th November was found to give significantly higher heat use efficiency, grain yield, biological yield and water use efficiency (Table 4.6, 4.9, 4.18, 4.19 and 4.21).

5.5 Economics

A perusal of data indicated that maximum net return and B:C ratio was found with sowing of GW 366 on 15th November (Table 4.31 and Fig. 4.43). The significantly higher yield with sowing of GW 366 on 15th November and no substantial difference in cost of cultivation with sowing on 15th November resulted into higher net return and B:C ratio with sowing of GW 366 on 15th November.