CHAPTER V

DISCUSSION

The results pertaining to the effects of different treatments of varieties, nitrogen, mulches and their interactions on the growth, yield, nutrient and water use presented in the preceding chapter have been discussed in detail in this chapter. An attempt has also been made to suggest certain improvements which might go in to improve the overall management of wheat crop under soil moisture and nutrients constraints normally experienced in the dry areas.

It would be useful to highlight the important climatic parameters of the two experimental seasons which have been responsible for many of the variations in the experimental results. In 1973, about 90% of the total crop season rainfall (9 cm out of the total 10.1 cm) was received up to 20th January i.e. up to the 9th week of the crop growth which created a better crop environment especially for the temperature and relative humidity in the initial stages of the crop growth including seedling establishment. This directly reflected on the comparative reduction in the use of irrigation water in the early stages in 1973 compared to that in 1972 where 9.5 cm rain was received after January i.e. after the 11th weeks of sowing.
Total number of irrigations thus applied in 1973 was actually one less than those applied in 1972. Early rains resulted in higher crop stand, more number of shoots/plant, and a higher dry matter production. Better initial establishment could enable plants to utilise moisture and nutrients more efficiently from a greater soil depth and volume. In 1972, the late rains were not as effective as the early rains in 1973 because in the initial stages when the roots are shallow and the plants are to depend mainly on the water and nutrients available in the surface layers, early light rains are useful while late light rains reaching only up to few centimetres in to the soil may not be as useful for the roots gone deep into the soil as when these were restricted to the surface layer in the early stage.

VARIETAL EFFECTS:

One of the primary ways that man has manipulated his production or yield in a particular environment is to simply select plant types adapted to the existing situations especially climate and available water. As reported by many research workers the dwarf and the semidwarf wheat varieties have established a higher grain yielding genetic potential for a given level of nitrogen and water available. Kalyan Sona in the semidwarf group and Moti in the dwarf
yielded higher dry matter and grain compared to Sonalika and Heera. The grain yield of Moti was maximum in 1972 while that of Kalyan Sona in 1973 but between these two the differences were only little, if any. For a given level of nitrogen both these varieties (Kalyan Sona and Moti) had higher response for yield contributing characters like number of ear bearing shoots, ear length and the number of grains in a ear over Sonalika and Heera. As mentioned earlier the grain yield was higher in the year 1973 than that in 1972. The increase was mainly brought about by the increase in the number of shoots, leaves/plant and the leaf area index at peak (60 days) stage (Fig. 5 through 7). Better environments in 1973 in the initial stage caused due to frequent rains allowed higher rate of production of photosynthates resulting in higher accumulation of dry matter. Within the season, the varietal differences in dry matter production were brought about by the capacity of the individual varieties itself to make use of the resources available. In this context Kalyan Sona and Moti varieties proved efficient user compared to Sonalika and Heera. Better agronomical and physiological attributes of dwarfer wheat have also been reported by Suckler and Pauli (1961) and Singh et al. (1971). The marked variations were noted in yield contributing characters of spring wheat having different plant heights by Johnson et al. (1966). High total dry matter production in Kalyan Sona was mainly
associated with the increase in the height of the plant, number of shoots, number of spikelets and length of ears of the plants caused mainly for increased uptake of nutrients and water. Some such relations have been given in Appendix XXIX and XXXI.

The yield superiority of dwarf wheat has also been reported by several research workers (Anderson, 1963; Gandhi and Ray, 1964; Emphrat et al., 1964; Dutta, 1967; Swaminathan, 1968 and Singh and Dastane, 1971). In All India Coordinated Trials also (Anon. 1973), Kalyan Sona and Moti were proved higher user of nitrogen compared to Sonalika and Heera. Higher uptake of nitrogen is reported to increase the dry matter accumulation and also stimulates for higher uptake of other essential nutrients like phosphorus and potassium. Kalyan Sona utilized larger amounts of nitrogen (Sandhu and Gill, 1971; Chandravanshi and Singh, 1972; and many others) increasing thereby the nitrogen content of the grains (Singh, 1974). They noted that among the different varieties the uptake was in the order of Kalyan Sona > Sonalika > NP 884.

While discussing the availability of nutrients and their uptake, the role played by the availability of water in the soil can not be sidetracked. Besides all other factors, utilization of water in the rooting zone of the soil and even beyond is again the capacity of the individual
Variety. Kalyan Sona, relatively taller, produced maximum transpiring surface (leaf area index) and thus caused higher loss of water through transpiration while Moti required minimum being dwarfast with dense foliage. Dense foliage probably caused resistance for free movement of water vapours at peak atmospheric demand. Findings of Gupta and Dargan (1971) also suggest that dwarf varieties (PV 18 and S64) required 22.2-38.2 cm of water as their seasonal consumptive use. In the present investigation Kalyan Sona (29.1-33.9 cm), Sonalika (28.9-33.1 cm), Heera (29.1-32.8 cm) and Moti (28.4-32.9 cm) also followed the same trend. Many other workers like Singh and Baxtana (1970), Pareek and Bajpai (1971), Garg and Srivastava (1971), Cheema and Kaul (1974) and Jain and Jain (1975) have also reported the similar findings.

The economic use of water increased the water use efficiency. Moti, a dwarf wheat gave highest water use efficiency (18.6-24.5 kg grain/mm water/ha) followed by Kalyan Sona (17.3-23.4 kg grain/mm water/ha) being higher than those of Heera and Sonalika. Water use efficiency is the function of yield and evapotranspiration (ET). In other words, the water use efficiency could be increased by increasing the yield or reducing the total water used. Kalyan Sona yielded highest and also used higher amount of water (higher ET) while Moti yielded comparable to Kalyan Sona
but used comparatively less total water resulting in the higher water use efficiency. Results reported by Cheema and Kaul (1974), Singh and Ramakrishna (1975) and Talha (1973) are also in conformity with the above findings.

Availability of soil moisture is directly linked with the depletion of soil moisture from greater depths. This again depended on the plant types and the environment. Uniform depletion of moisture from deeper layers helped plants grow vigorous and yield higher through proper development of their rooting systems. In these studies Kalyan Sona and Moti utilized higher amount of water from the deeper layers (Fig. 14 and 15) resulting in higher uptake of nutrients and also the yield. Similar results for Kalyan Sona variety were also reported by Jain and Jain (1975) and for several dwarf varieties by Singh and Bajtane (1971).

NITROGEN EFFECTS:

Efficiency in the use of water by crop may be said to increase with the supplies of all nutrients up to those associated with maximum yield. Use of nitrogen at higher levels in the present studies favoured increase in the growth and yield attributes in both the years. At 150 kg N/ha, plant height, number of shoots, number of leaves, leaf area index and dry matter production increased significantly over 60 kg N. Higher level of nitrogen permitted higher
uptake of nutrients and water which stimulated the chlorophyll synthesis and total photosynthates resulting in a higher accumulation of dry matter in two years. The rate of increase in the dry matter production was higher between 60-120 days after sowing under 150 kg nitrogen level. The rate thereafter decreased till maturity. Higher number of shoots, taller plants and more dry matter accumulation with high nitrogen level was achieved through the increased availability of water. Similar findings regarding the effects of increased nitrogen were reported by Watson (1939), Rohde (1963), Singh and Verma (1965), Singh (1967), Singh and Gupta (1970), Sandhu and Gill (1972), Singh and Anderson (1973) and Lal and Sharma (1973). Correlation studies (Appendix XXI through XXII) have indicated that the yield of grain is highly correlated with the number of grains/ear, length of the ear and number of spikelets/ear. With increased nitrogen level, 1000 grains weight decreased by 2-3%, probably for increased number of grains/ear. Similar relations have also been reported by several earlier workers (Watson, 1936; Rao et al., 1957; Tivari and Singh, 1969; Suri and Singh, 1970; Sharma, 1970; McNeal, 1971; Misra and Singh, 1971; and Singh, 1973).

The uptake of nitrogen increased with the age of the crop but the rate of increase was higher with 150 kg N compared to 60 kg. High amount of applied nitrogen brought higher uptake of nitrogen and thus a vigorous growth of
foliage and roots as well. Well developed root system could absorb higher amount of water and also nutrients like phosphorus and potassium. At later stages nutrients were translocated from older leaves towards younger leaves and grains. As per their mobility, a major portion of nitrogen and phosphorus accumulated in grains while potassium being relatively immobile remained higher in straw. Singh (1963) and Bhargava and Motiramani (1967) also reported similar results while Solaria and Mann (1964) noted maximum uptake at booting stage and there was no effect of phosphorus and potassium on the nitrogen uptake. Increased nitrogen content increased protein yield in grain, as reported here, was also noted by Austin and Jhamb (1964). Satyamrayam (1971) and Hunter and Ford (1973). Higher total dry matter production at 150 kg N/ha resulted in decreased nitrogen use efficiency. Higher level of nitrogen did increase grain as well as dry matter yield but the rate of increase was low for each conditional dose of nitrogen above 60 kg and this caused reduction in nitrogen use efficiency compared to 60 kg N. Similar findings were also reported by Hajjetti and Malzki (1972).

Daily consumptive use of water increased with the age up to 120th day after sowing, later decreased due to decrease in the total transpiring surface of the leaves near maturity. Peak use was attained at ear and grain filling
stage (Gupta and Dargan, 1971 and Prasham and Singh, 1963a). Increased level of N (150 kg N) increased seasonal consumptive use by 0.9–2.5 cm over low level (60 kg). Similar findings were also reported by Singh et al. (1971), Pareek and Bajpai (1971), Gowda and Patil (1973) and others.

Water use efficiency markedly increased at 150 kg N over that of 60 kg throughout the life period of the crop. Higher level of N increased the total biomass production including roots allowing higher uptake of water and nutrients. As noted earlier (Fig. 16), moisture extraction from deeper layers increased by increasing level of N under a specific variety. Higher total moisture depletion was observed in fertilized than unfertilized crop and the extraction in cases of higher level was more from the deeper layers. In other words, application of nitrogen permitted a higher uptake of soil moisture resulting in increased time water utilization efficiency through increased dry matter production.

**Mulches Effects:**

Under water scarcity conditions reasonable yield is not possible unless the steps are taken to conserve and make best use of the available water. Under such situations where a larger portion of the available water is lost from the soil as evaporation, use of mulches, in general, increases the water availability in root zone.
through conservation and enhances the growth of the plants besides increasing the availability of water and plant nutrients. Mulches, for being organic in nature, stimulate the activities of microorganisms also. In the present study, use of saw dust, however, probably locked up the nutrients temporarily by decomposing microorganisms acting on the organic matter used as mulch material on the surface. This caused an initial nutrients deficiency, especially in nitrogen, resulting in slow initial growth of the plants. At later stages, however, the locked-up nitrogen was released and thus the nutritional benefits were noted higher at the reproductive and maturity stages. Amongst the different kinds of mulches used, polyethylene sheet reduced the nutrients and water losses to the minimum and also depressed weeds growth, microbial immobilization and vaporization losses. Cumulative effects of these was reflected in increased LAI which caused high synthesis and accumulation of dry matter. The effectiveness of mulches increased with the crop age.

Increase in the vigour of the plant by leaf mulched plots over no mulch showed superiority in all respect of growth (Samad et al., 1957) and also the mulches modified the environment by conserving soil moisture and increased uptake of nutrients (Rowe and Dutton, 1957; Zingg and Whitfield, 1917). Chaudhary and Chatterjee (1967) noticed more plant
growth and root development under straw mulched plots than no mulched ones. Increase in the number of leaves, tillers, grain and straw yields of crop with mulched treatment was highly significant (Ali and Prasad, 1972; Tiwari et al., 1970). Effectiveness of polyethylene was reported by Sanders and Clark (1961), and Emmert (1957) while superiority of straw mulch by Brost and Mederski (1957), Army et al. (1961), Moody et al. (1963), Adams (1966) and others. Mohan Kumar et al. (1973) reported increased plant height, base of girth and canopy of plants by introducing mulch.

As reported by several other workers, the effectiveness of mulches in increasing the grain yield and attributes in the present studies also was achieved though increased availability of water and plant nutrients, two major resources primarily responsible for reducing the crop yields, by directly reducing evaporation and decreasing transpiration through controlled weeds. In polyethylene mulched plots weeds were comparatively suppressed thus permitted a higher water use efficiency by minimising plant competition. Besides these, mulches may have reduced the adverse effects of advective heat by providing insulation to the soil surface for proper maturity at the later stages of crop growth as reported by Rowe and Dutton (1957), Brower (1968), Bains (1969), Rajput and Singh (1970), Ali and Prasad (1974), Singh et al. (1974), Makarov and Moschenko (1975) and Abrol and Dhamkar (1973).
Nitrogen uptake was higher in case of polystyrene and sand mulches compared to saw dust. As mentioned earlier the nitrogen get locked up temporarily by the micro-organisms. The availability of nitrogen in surface soil layer was found more, firstly because of proper moisture and insulation on the surface, and secondly because of the reduced losses through volatilisation and weeds, this, as noted, increased the availability and uptake of nitrogen through well developed root system. Higher soil moisture content maintained at surface layer permitted higher available nitrogen in soil solution. Under control treatment moisture from surface soil get lost rapidly that reduced N mineralization and uptake by plants. Under mulched condition, besides N, availability of phosphorus and potassium also increased. This was probably due to the changed soil conditions towards temporary acidity caused by increased solubility of carbondioxide in soil solution, production of some organic acids in decomposition, and increased ionization of phosphorus and potassium. In saw dust mulch, however, the availability of these nutrients was also compared to other two mulches. Increasing activity of decomposing organisms also made use of these nutrients and deprived the plants of its share. The findings of Mc Calla and Army (1961) showed that organic mulch reduced the nitrate
content in soil and increased the soluble potassium. Ranhe et al. (1961) also reported that application of potato tops as surface mulch increased the uptake of potassium by 31% and yield by 27%. In total the nutrient uptake increased by 40–66%. Under adequate nitrogen supply mulching increased the protein content and nitrogen yield in grains (Black, 1973) but contrary Rajput and Singh (1970) reported decreased nitrogen content of grain under mulching when nitrogen was not adequate.

Out of the various mulches tried, polyethylene mulch was most effective in reducing the daily consumptive use of water. The peak daily consumptive use decreased by 6–12, 25–37, and 37–115% by application of sand, sawdust and polyethylene mulches over control respectively. The efficacy of mulches was to reduce evaporation from the soil surface and to help maintain adequate temperature in warm windy days by creating resistance in the path of evaporation. Mulches also increased the insulation of the soil surface against the advective energy of the solar radiation. The reduction in the evaporation directly affected the consumptive use of water. The consumptive use in early stages was lower due to inadequate growth while near maturity the yellowing and drying of leaves reduced the total transpiration.
Maximum rate was achieved at maximum growth stage in the month of February - March. Higher reflection (albedo) of solar radiation in case of polyethylene mulch reduced the losses to a greater extent through its effect on reduced surface temperature and rate of evaporation. Controlled weed growth was another important factor checking water losses through transpiration. Hazra et al. (1973) reported the effectiveness of organic mulch in conserving soil moisture in Delhi conditions in the upper 45 cm depth of soil layer while Chaudhary and Chatterjee (1967), Rajput and Singh (1970) and Tiwari et al. (1970) reported the effectiveness in lower soil depths. Similarly, the usefulness of polyethylene mulch in conserving moisture in soil was reported by Emmert (1957), Willis (1963), Waggonier et al. (1960), Sanders and Clark (1961), and Griffin et al. (1966).

Total consumptive use were decreased by 8-22, 11-31 and 21-38% and the number of irrigations by 1-2, 2-3 and 3-4 by use of sand, saw dust and polyethylene mulches respectively over control. The yield so increased by the use of mulches increased water use efficiency by about 13-14, 23-26 and 49-60% under above mulches respectively compared to no mulch. The water use efficiency on grain basis increased more markedly than on total dry matter basis. The reduction in the evaporation
and water use and increased yield due to better uptake of nutrients resulted in increased over all water use efficiency at all stages of crop growth. Similar effects of mulching were also reported by Bansal et al. (1971), Koshi and Fryrear (1971), Griffin et al. (1966) and many others.

The moisture depletion pattern was also greatly affected by the use of surface mulch. Polyethylene was found more effective in reducing the water depletion from 20-60 cm depth. From upper layer (0-20 cm), however there was a higher depletion from polyethylene mulched plot followed by saw dust and sand mulch. In case of control plots, deficit of soil moisture in the surface layers due to high evaporation forced the plants to absorb moisture from deeper layers (40-60 cm). The horizontally spreading root system thus experienced moisture deficits while vertical roots absorbed water from deeper layers but at the high expanse of plant energy. Reduced moisture depletion under mulched conditions was primarily due to the reduced rate of evaporation from the soil. This has also been reported by Samad et al. (1957), Adams (1966) and Griffin et al. (1966).

**INTERACTION EFFECTS:**

The effect of the interaction between varieties x nitrogen was more pronounced on the height of the plants, number of shoots/plant and leaf area index. Higher
Higher nitrogen level applied to Kalyan Sona in semidwarf and Moti in dwarf wheat group resulted in higher total dry matter accumulation while Heera and Sonalika gave poor response to the applied nitrogen. Better growth attained by increased utilization of nitrogen and water resulted in higher yields of Kalyan Sona and Moti varieties. Higher genetic potential of Kalyan Sona and Moti due to their enlarged root system helped in higher uptake of nutrients resulting in increased total canopy and higher dry matter through increasing leaf area index and enhanced photosynthetic activities.

The effect of nitrogen x mulch interaction was more distinct at the higher level of nitrogen. Polyethylene mulch used in plots with 150 kg N/ha produced higher yield of grain and also total produce by increasing the uptake of nitrogen and its assimilation in grains and rapid translocation from vegetative parts. At low level of nitrogen (60 kg), saw dust, due to utilization of some nitrogen by micro-organism in the initial stage, gave poor performance while under no mulch the losses of nutrients and water were increased due to weed infestation and unrestricted evaporation from the soil. The nitrogen uptake was found maximum under sand mulch at both the levels of nitrogen, probably due to the improvement in the
physical condition of the soil by sand application. Maximum water use was recorded under high level of nitrogen without mulch while minimum water loss was recorded from polyethylene mulched plots. For these reasons, the water use efficiency was higher under polyethylene mulch at higher level of nitrogen while minimum at low level applied without mulch.

The effects of variety x mulch interactions were also noted with significance. Polyethylene mulch with all the varieties gave increased number of shoots at harvest due to increase in leaf area index and number of leaves at peak period. Moti and Kalyan Sona under polyethylene mulch yielded highest. Mulches reduced evapotranspiration through reduced evaporation loss from the surface and thus increased water use efficiency of these varieties. The highest water use efficiency under polyethylene mulch was assigned to reduced nutrient and water losses by suppressing weeds growth, reduced surface evaporation and creating favourable soil environment for the availability of water and nutrients. Findings of Singh and Anderson (1973), Talha (1975), Mazzetti and Maleki (1972), Viets (1964) and Bains et al. (1968) have also shown similar results.

Moisture depletion from deeper layers was higher under high level of nitrogen applied without mulch while with mulch the depletion was more or less uniform from all
layers. Under polyethylene mulch the maximum moisture depletion took place from the upper layers because of higher availability in the upper surface. With increased N level the depletion increased especially by Kalyan Sona and Moti varieties.

The economic analysis indicated that maximum yield from each varieties were slightly higher than the optimum yield. The optimum and maximum yields depended upon the nitrogen uptake and corresponding consumptive uses. Higher levels of nitrogen gave higher net profits from the crop. Mulches though produced higher physical yields but, for having high cost of the material used, the economics or say the net profit decreased. In other words, in high value cash crops or in case of high prices for water these mulches have a significant place in crop production. Alternative to polyethylene, sand dust and saw dust could also be used. The choice of mulch, besides other factors, will also depend on the economics of the material itself.