CHAPTER 5

Discussion
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5.1. INTRODUCTION

The vitamins are needed in small amount for normal growth and development of organisms because they are catalytic in their function. All known vitamins except vitamin D are synthesized by the green plants, that's why we suppose that exogenous application of vitamins will have no fruitful effects on plants. The vitamins act as coenzymes and very often they are essential for the action of many enzymes and therefore, play a vital role in the cell metabolism. The vitamins, as the growth regulators of some of the most important processes of metabolism, take part in the synthesis of amino acids, protein, purine and pyrimidine bases and nucleic acids. Although the vitamins are synthesized by the plants, however some times amount of vitamins produced by the plants may not be sufficient for adequate development of the economically important characters (Sinkovics, 1974). The synthetic capacities of many plants and their parts to produce vitamins are markedly different therefore, it is believed that some plants and their parts at certain developmental stages may contain slightly sub-optimal amount of vitamins and may therefore, be stimulated by exogenous application of vitamins (Kodandaramaiah and Gopala Rao, 1984).

Vitamins of the B-group, acting as co-enzyme, also participate in various plant processes. Additional supply of vitamins can exert positive response on physiological process of plants and on growth and development of plants has long been established (Bonner and Bonner, 1948; Aberg, 1961;
Burstrom, 1961). Vitamin C has been found to enhance the seed germination as well as growth and yield of mature plants (Chinoy, 1967; Chinoy and Saxena, 1978).

In the present work an attempt has been made to consider the data of four field experiments from the point of view of growth, yield and quality as affected by pre-sowing seed treatment with B-vitamins and C. The various studied parameters were found positively significant in all experiments.

5.2. EXPERIMENT-1

The result of this experiment revealed significant response of vitamin B₁ (thiamine) on growth, yield and quality of *Triticum aestivum* L.

Application of vitamins to seed before sowing seems to enhance the level of endogenous seed vitamin which pushes up the emerging seedlings. Due to additional amount of vitamin, seedlings would expectedly continue to perform better even at later growth stages of plant.

The importance of vitamin B₁ as root growth factor has long been well established (Bonner, 1938; Bonner and Green, 1938; Went *et al.* 1938; Addicott, 1939; Arnon, 1940) Robbins 1951 also reported the essentiality of one or two vitamins tried by him, namely B₁, B₆ and niacin for root growth. Later a similar effect of vitamin B₁ was reported by other workers in a wide variety of tree crops (Pyasyatskene, 1974 in *Arctostaphylos uvaursi*, Mukherjee and Sikdar, 1974, 1977 in *Morus alba*; Tomar and Arya, 1990 in *Prosopis cineraria*) as also for several ornamental and crop plants (Vergnano, 1959 in *Hedera helix* and
Increased root growth would naturally enhance the absorption of water, essential nutrients and other accessory factors from the soil and result in vigorous shoot growth.

Plant height is an important growth parameter which responded to seed treatment with vitamin B1. The maximum height was recorded in 0.8% vitamin B1 solution (Table-7). Similar effect of vitamin B1 was reported by (Reda et al., 1977; Kulieva et al., 1976).

Seed treatment with vitamin B1 also increased the leaf number (table-8). The increase in leaf number is due to enhanced tillering as a result of vitamin B1 treatment (Table-10). Normally enhanced leaf production would lead to an increase in the area of assimilatory surface that determines dry weight per plant. Dry weight is an important growth characteristics. Any agrotechnique that enhanced dry weight of crop plants would therefore be welcomed by the farmers. In the present experiment vitamin B1 treatment significantly enhanced the dry weight per plant (Table-12). The highest value was recorded in the 0.8% vitamin B1 treatment. It was also reported that leaf area index (LAI) was higher in vitamin B1 treated plants than control (Table-9). Over all it was concluded from above obtained data that vegetative growth was significantly improved by the application of vitamin B1. Similar positive response of vitamin B1 was reported earlier by (Murneek, 1941; Iijima, 1952; Barbieri, 1959; Das and Das, 1966;
Serebrykova and Kalanova, 1977; Mukherjee and Sikdar, 1977; Qaseem et al., 1996).

The main effect of every agronomic study is to find out the effect of treatment on the economic yield of crop. The yield is the cumulative effect of yield components such as number of reproductive units per plant, number of grains per reproductive unit and average weight per grain.

Pre-sowing seed treatment with vitamin B₁, was found optimum for most of the yield characteristics and grain yield. 0.8% vitamin B₁ treatment was recorded best for grain yield (Table-14). In this treatment grain yield increased by 10.52% over control. The per cent increase in grain yield over control was mainly due to reproductive unit per plant, number of seed grain per reproductive unit and 1,000 grain weight as explained below.

Vitamin treatment positively influenced the spike number per plant, spikelet number per spike and 1,000 grain weight. The concentration of 0.8% vitamin B₁ was found most effective for spike number per plant. It increased the spike number by 20.48% over the control. Spikelet number per spike was also recorded optimum in 0.8% vitamin B₁ treatment which increased by 4.44% spikelet number over the control (Table-13). The seed number per spike was proved maximum in 1.0% vitamin B₁ treatment. It increased by 12.43% over control. Next to maximum increase in seed number per spike was recorded in 0.8% vitamin B₁ concentration. It increased by 12.40% over the control where vitamin B₁ was zero per cent. Maximum increase in 1,000 grain weight was recorded in T₄ (0.8% B₁) treatment. It increased by 3.31% over the control.
Similar effect of vitamin B₁ on yield and yield characteristics was reported earlier (Aizikovicks, 1967; Kulieva et al., 1976).

Application of vitamin B₁ also improves the quality of the seed as the concentration of the protein and carbohydrate. Protein and carbohydrate yield q/ha was also found significant with vitamin B₁ treatment (Table-15). The increase in the amount of these energy rich substances with a small quantity of vitamin B₁ could go along way in solving the problem of malnutrition.

5.3. EXPERIMENT-2

In experiment-1 the best concentration of vitamin B₁ was found in 0.8% to 1.0% aqueous solution where seeds of wheat variety PBW-154 was soaked for 24 hrs before sowing. A second experiment was therefore, performed on wheat in petridishes with the addition of other vitamins, vitamin B₆ and C which had a great effect on the growth and development of seedling growth.

It is well known that seed germination and seedling growth play an important role in life cycle of a plant. Factors that influence seed germination and early seedling growth affect development profoundly at subsequent stages. Availability of growth regulators including vitamins play a crucial role during and after seed germination. The importance of vitamins for the processes regulating early plant growth is reported by (Oertli, 1987; Samiullah et al., 1988).

It is obvious from the data of experiment on *Triticum aestivum* L. that pre-sowing seed treatment with vitamins proved significantly beneficial for growth of seedling (Table 17,18). Seed germination percentage was found
statistically non significant. However, the seed germination percentage increased slightly. The increase in the growth of root as a result of vitamins treatment is expected to provide additional surface area for absorption of water and mineral nutrients and thus to ensure better seedling growth. This is conformed by enhanced fresh weight as well as dry weight (Table-18). Similar positive effect of vitamins on seed germination and seedling growth has been reported by many workers on different plants (Chinoy and Saxena, 1978; Asthana and Srivastava, 1978; Afridi et al., 1985; Sharma et al., 1984; Dey and Choudhuri, 1982; Orzolek, 1983; Ansari et al., 1990; Samiullah et al., 1991).

Pre-sowing treatment of seeds is known to increase their tissue hydration, respiratory activity and distribution of nutrient reserves, resulting in enhanced seedling growth (Dawson, 1965). It also brings about profound changes in the endosperm and pre-determines the expression of various growth and developmental characters (Dave and Gaur, 1970). Among the chemicals known to stimulate seed germination in a wide variety of crops, the vital role of gibberellic acid (present in the seed or supplied exogenously) has received wide attention (Mc Laren, 1982; Bewley and Black, 1982). In the present study the vitamins used could either mimic the role of gibberellic acid or raise level in the seed (Oertli, 1987). Either of these phenomenon would stimulate m-RNA production and enhance the activity of hydrolyzing enzymes (Bewley and Black, 1982). The increased hydrolysis of food reserves in the germinating seeds would consequently enhance the availability of respiratory substrate for energy production and nutrition and could thus account m-RNA and increase total
nucleic acid content (Chinoy, 1984). Thus it modifies genetic coding and thereby controls the biosynthetic process as well as reaction velocities of different enzymes. In present experiment our data also shows that vitamin treatment enhance the seedling growth (Table 17 and 18).

5.4. EXPERIMENT 3 AND 4

On the basis of seedling growth in different aqueous concentrations of vitamin B$_1$, B$_6$ and vitamin C in experiment 2, a field trial was conducted in third and fourth experiments in the year 1995-96 and 1996-97 on three wheat varieties (Loke-1, PBW-154 and HD-2285) and barley variety Jyoti. These experiments were carried out according to split plot design to study the effect of pre-sowing seed treatment with vitamins on growth, yield and quality characteristics of three varieties of *Triticum aestivum* L. and single variety of *Hordeum vulgare* L. in field under natural conditions. Vitamins treatment in general positively influenced most of the growth and yield parameters of *Triticum aestivum* and *Hordeum vulgare*.

It is well known that vitamin C plays a number of roles in growth and development of plants (Chinoy, 1977; Rebrisoreanu, 1971; Bonner, 1957; Allen and Hall, 1973; Tonzig and Marre, 1961). It’s involvement in nucleic acid metabolism is also well established (Chinoy et al., 1957; Price, 1966; Mathew et al., 1978). Theoretically vitamin C application might have induced DNA activity by binding the excess amount of histones (Fellenberg, 1969). Alternatively, addition of vitamin C might have enhanced nucleic acid content (Chinoy and Saxena, 1971; Mathew et al. 1978). Thus vitamin C by removing excess amount
of inhibitory histone from DNA, paves way for the creation of additional template site in the DNA molecule which provides m-RNA and finally specific structural and enzymatic proteins (Chinoy et al., 1971). Positive response of vitamin C on rooting has been reported by many workers (Mukherjee and Sikdar, 1974, 1977; Pyasyatskene, 1975, 1971; Bose et al. 1982; Grzyb et al. 1986; Bhardwaj and Rai, 1987; Trivedi and Singh, 1988). The recent finding that vitamin C could have physiological regulatory role in cell division and cell proliferation (Liso et al., 1984; Innocenti et al., 1990).

As discussed above, vitamins might have played a vital role in developing a profuse root system. Such a well developed root system could subsequently improve the growth and development. This enhanced root growth would be expected to increase the absorption of water, essential mineral nutrients and other accessory factors from the soil leading to better performance of the crop in terms of growth parameters viz. Plant height, leaf number, tiller number, fresh weight, dry weight of vegetative plant and growth components.

Plant developed from vitamin soaked seeds showed high value for length of plant in all three varieties of Triticum aestivum L. and Hordeum vulgare L. Treatment T₆ (0.8% B₁ + 0.01% B₅ + 0.01% C) was found best for length of the plant. At 90 days stage the length of plant increased by 5.72%, 1.89% and 2.84% over the control in wheat varieties Loke-1, PBW-154 and HD-2285 respectively (Table-21). At the same sampling stage the length of the plant increased by 2.05% over the control in barley variety Jyoti (Table-54). Similar effect of vitamin
on length of plant have been reported earlier by Chinoy et al. 1970; Casillas et al. 1986; Ansari et al. 1990 and Samiullah et al. 1991, 1992.

Positive significant response of vitamins application on leaf number was observed at each sampling stage i.e. 50, 70 and 90 days. Treatment T6 (0.8% B1 + 0.01% B6 + 0.01% C) was found best. At 90 days sampling stage the leaf number increased by 4.74%, 8.73% and 9.18% over the control in wheat variety Loke-1, PBW-154 and HD-2285 respectively (Table-24). In barley same treatment was recorded optimum for leaf number at every sampling stage (Table-55, 56, 57). Leaf number increased by 7.79%, 6.86% and 6.63% over the control at 50, 70 and 90 days sampling stage respectively in barley. Wheat and barley being monocot the increase in leaf number could be attributed to enhance tillering as a result of vitamins treatment (Table-28, 29 and 30 for wheat and 61, 62 and 63 for barley). The values for leaf area index (LAI) were also found higher in the treatment containing vitamins (Table-25, 26 and 27 for wheat and 58, 59 and 60 for barley).

Plants developed from vitamin soaked seeds showed high value for dry weight in both wheat and barley (Table-34, 35 and 36 for wheat and 67, 68 and 69 for barley). Dry matter production is mainly dependent upon the photosynthetic activity. Expectedly increased leaf area would promote assimilatory activities resulting in increased dry weight. Fresh weight also showed positive response with vitamins applications (Table-31, 32 and 33 for wheat and 64, 65 and 66 for barley). The value of crop growth rate was also recorded high in vitamin treated plants (Table-37 and 38 for wheat and 70 and

Basal fertilizer dose significantly affected the morphological characteristics in terms of growth parameters viz. length of plant, leaf number per plant, tiller number per plant, fresh and dry weight and growth components.

Macro nutrients are very important for growth and development of plants. For optimum growth of plant the concentration of nutrients in the soil solution should be maintained at the critical value below which the growth of the plant is decreased (Mengel and Kirby, 1982). Nitrogen and phosphorus play a paramount role in the growth and development of the plants and occupy a prominent position in plant nutrition. Some of these nutrients constitute an integral part of several biologically important macro molecules including amino acids, nucleosides, co-enzymes, purines, pyrimidines, nucleotides, intermediary metabolites and some growth hormones (Develin and Witham, 1986; Salisbury and Ross 1986) which directly regulate plant metabolism. Purine and pyrimidine are the basic units for the synthesis of protein and enzymes. Nitrogen plays an important role in metabolic process (Nason and Mc Elroy, 1963). Nitrogen is
primarily required for cell growth and division. The positive significant response of nitrogen on root growth was reported by many workers in various tree crops (Joiner et al., 1980 and Sehgal et al., 1992). Enhanced root growth is expected to absorb more water and nutrient from the soil leading to enhancement in vegetative growth in terms of plant length, leaf number, tiller number, leaf area, fresh weight, dry weight etc. similar effect on growth has been reported by many workers (Sivanadayan, 1972; Weeks et al., 1958; Hinson, 1975; Foster and Goh, 1977; Campbell and Leyshon 1980; Haby et al., 1991).

In the present experiment all growth parameters (length of the plant, leaf area, fresh weight and dry weight) and growth components were significantly affected with NPK application in both wheat and barley. Full basal fertilizer dose (N\textsubscript{120}P\textsubscript{60}K\textsubscript{40}) was found significant over half basal fertilizer dose in wheat (Table 19-38). In barley full basal fertilizer dose (N\textsubscript{60}P\textsubscript{30}K\textsubscript{20}) was also found significant over half basal fertilizer dose (Table 51-70). These observations conform the earlier reports (Conover and Poole, 1976; Pokhriyal et al., 1988; Agrawal, 1981).

The ultimate aim of every treatment is to find out the effect of treatment on economic yield of crop. Yield is the cumulative effect of yield components. It means that if the number of the reproductive units per plant, number of grain per reproductive unit and 1,000 grain weight is affected, the yield will be affected.

In the present experiment the yield and yield components were found statistically significant with vitamins application. The treatment T\textsubscript{6} was
found optimum for grain yield in both wheat and barley. Treatment T7 was critically same with treatment T6. Grain yield increased by 19.63%, 17.32%, 18.63% and 21.06% over control in wheat varieties Loke-1, PBW-154 and HD-2285 and barley variety Jyoti respectively (Table 44 for wheat and 77 for barley). Number of spike per plant was found significant with vitamins treatment. In wheat varieties Loke-1 and HD-2285, the number of spike was recorded highest in treatment T6 and in variety PBW-154 the highest value for number of spike was recorded in treatment T7. The number of spike increased by 18.97%, 32.02% and 21.97% over control in wheat variety Loke-1, PBW-154 and HD-2285 respectively (Table-39). The number of spike per plant was also enhanced in barley with vitamins applications. Treatment T6 was recorded optimum in which the number of spike increased by 20.12% over control (Table-72). Number of spikelet per spike was also increased by 8.27%, 8.15%, 15.13% and 12.56% over control in wheat varieties, Loke-1, PBW-154 and HD-2285 and barley variety Jyoti respectively (Table 41 for wheat and 74 for barley). Number of seed per spike was also found statistically significant over control for both wheat and barley. Treatment T6 was proved best. The number of seed per spike increased by 32.44%, 19.74%, 21.08% and 9.07% over control in wheat varieties Loke-1, PBW-154, HD-2285 and barley variety Jyoti respectively (Table 43 for wheat and 76 for barley). One thousand (1,000) grain weight also increased with vitamins treatment. 1,000 grain weight increased by 1.96%, 2.18%, 3.93% and 3.37% over control in wheat varieties Loke-1, PBW-154 and HD-2285 and barley variety Jyoti respectively (Table 42 for wheat and 75 for barley). The increased grain yield
seems to be the result of increased spike number per plant, grain number per spike and 1,000 grain weight.

Significant response of vitamins treatment on husk yield was also observed. Treatment T7 was found best in wheat varieties Loke-1, PBW-154 and barley variety Jyoti in which husk yield increased by 16.50%, 9.84% and 16.92% over the control respectively (Table 45 for wheat and 78 for barley). In wheat variety HD-2285 treatment T2 was recorded optimum in which husk yield increased by 11.51% over control. Similar beneficial effect of pre-owing seed treatment with vitamins on yield and yield components has been reported by other workers (Kjelvik, 1965; Gutmanis, 1967; Genkel, 1970; Sinkovics, 1974; Rao et al., 1976; Afridi, et al. 1979; Padole, 1979; Ashfaq et al., 1983; Mehrotra et al., 1983; Khan and Zaidi, 1985; Ansari and Khan, 1985; Ansari et al., 1990; Samiuillah et al., 1991, 1992).

A significant positive response of vitamins application on carbohydrate and protein yield q/ha was observed. The increased in carbohydrate production q/ha in all treatments over control is also understandable because in wheat, barley and other starchy seeds the weight of grain mostly depends upon the accumulation of carbohydrate in the grains. Treatment T7 was found significant for wheat varieties Loke-1 and PBW-154. While in wheat variety HD-2285 and barley variety Jyoti treatment T6 proved optimum. The carbohydrate yield q/ha increased by 20.24%, 17.55%, 23.32% and 22.30% over the control in wheat varieties Loke-1, PBW-154, HD-2285 and barley variety Jyoti respectively (Table 50 for wheat and 83 for barley). The
protein yield g/ha was also significantly increased by the application of vitamins. Treatment T6 was found best for all the varieties of wheat and barley. The protein yield g/ha increased by 29.09%, 18.67%, 22.94% and 24.18% over the control in wheat varieties Loke-1, PBW-154, HD-2285 and barley variety Jyoti respectively (Table 48 for wheat and 81 for barley). Similar effect of vitamin on protein and carbohydrate yield was reported earlier by Ahmad et al., 1986 and Shaddad et al., 1990.

On the comparison the yield and yield characteristics with the treatment T0 at both half and full basal fertilizer dose, the performance of wheat and barley varieties in experiment 3 and 4 at the same level of treatment is almost equal in half and full basal fertilizer doses. The yield and yield characteristics increased in full basal fertilizer doses as compared to half basal fertilizer doses in all the vitamins treated plants. However, in full basal fertilizer dose of the control T0 (seeds soaked in DDW), the grain yield decreased 7.97%, 6.83%, 6.97% and 1.86% as compared to the treatment T6, the plant seeds soaked in vitamin B1 (0.8%), B6 (0.01%) and vitamin C (0.01%) and supplied with half fertilizer dose as basal dressing in wheat varieties HD-2285, Loke-1, PBW-154 and barley variety Jyoti respectively. This increase in yield and yield characteristics in vitamin treated plants supplied with half basal fertilizer doses may be due to the longer roots and large number of new root hairs which increase the absorbing surface of the root make it more efficient to absorb more water and nutrients from the soil which go deep in the soil due to the irrigation water and not available to the plant which have shorter root, although supplying
with full fertilizer dose as basal dressing. These findings are the conformity with Samiullah et al., 1985; Ansari and Khan 1986. According to them pyridoxine induced modification of various physiological process in cereals, legumes and oil crops enable them to utilise the costly fertilizer more efficiently and thus pave the way for higher productivity and improve quality of the product. Therefore, it may be concluded that at the same treatment level the plant perform better in full basal fertilizer dose as compared to the half basal dose of fertilizer, but the performance of all the vitamin treated plants supplied with half basal fertilizer dose produce more grains as compared to control of full basal fertilizer dose in almost all the treatments.

Positive significant response of vitamins treatment on carbohydrate and protein content in seed was observed. Expectedly carbohydrate and protein percentage in seeds increased due to increased absorption of mineral nutrients. As discussed earlier that vitamins treatment enhance the root growth (Mukherjee and Sikddar, 1974, 1977, Trivedi and Singh, 1988; Tomar and Arya, 1990). This enhanced root growth would be expected to accelerate the absorption of water and essential nutrients. Phosphorus and nitrogen are known to increase the grain carbohydrate and protein content. This increase in carbohydrate and protein is due to the increased absorption of phosphorus, nitrogen and other mineral nutrients by roots. Similar effect of vitamins on carbohydrate and protein was observed by many workers (Afridi et al., 1985; Ansari and Khan, 1985; Ahmad et al., 1986; Ansari et al., 1990; Shaddad et al., 1990).
In the end, considering the overall picture discussed above it can be concluded that among the various combinations of vitamins, 0.8% B$_1$ + 0.01% B$_6$ + 0.01% C proved best to all other combinations of vitamins. It was also concluded that wheat and barley can be grown profitably by soaking the seeds in the above vitamin combination solution, followed by the application of half of the recommended basal fertilizer doses, thus achieving more grain yield and grain high nutritive value.

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