

## DISCUSSION

The results of the experiment on “**Integrated nutrient management on broccoli under north central plateau zone of Orissa**” conducted at RRTTS, Keonjhar in 2008-09 and 2009-10 have been discussed in this chapter with possible reasons for cause and effect for each and every phenomenon that had occurred during the investigation.

The crops responded positively to the direct and residual effect of graded doses of organic nutrients integrated with organic and biological sources either alone or mostly together. The biometrical parameters of broccoli crop like height of plant, leaf number, leaf area, curd weight and ultimately the yield were influenced synergistically by the stimulatory (capacity to synthesize and secret thiamine, riboflavin, pyridoxine, cyanocobalamine, nicotinic acid, pantothenic acid, indole acetic acid and gibberlic acid), therapeutic (ability of microbes manufacturing and secreting antibiotics and fungistic substances which protect the plants against fungal diseases), catalytic (*Azotobacter* encourage the population and activity of ammonifying and nitrifying bacteria like synergistically with *Rhizobium* and PSM and cellulolytic microbes), roles in addition to nutritional properties (  $N_2$  – fixation by *Azotobacter* 10-25 kg/ha, by *Azospirillum* 20-30 kg/ha, P solubilization equivalent to 30-40 kg  $P_2O_5$  /ha), by release of organic acids for solubilization of insoluble phosphates, making Al, Fe and Mn inactive by complex formation in acid soils and release of organic anions which compete with phosphate anion for adsorption/fixation and all round influence of organic matter (on physical, chemical, biological and nutritional properties of soil) on soil, as well as crop growth. These beneficial influences of both organic and biological

sources of nutrients had influenced nutrient absorption, uptake, utilization and recovery, there by converting inorganic nutrients in to different biochemical metabolites. This had resulted in greater biomass production, dry matter accumulation of the curd/plant (Sable and Bhamare, 2007).

The present results revealed that plant height in broccoli crop was influenced by the combined application of NPK and bio-fertilizers along with different organic sources. Application of only bio-fertilizers or 100% chemical fertilizers alone could not influenced significantly than the combined application in both the years tried. However, they individually differ significantly over control. The best results was obtained by the application of 100% NPK with bio-fertilizers along with organic source i.e., FYM and vermicompost which was significantly superior than other treatments (Plate 1, 2, 3, 4, 5). The application of biofertilizers might be attributed to longer amount of sustain supply of nutrients during the entire growth period. Significant increase in plant height might also be due to the production of different phyto hormones like Indole acetic acid, Giberlic acid and Cytokines produced by the biofertilizers. The increase in plant height might also be due to the action of phospho bacteria in synthesis of growth promoting substances like Vitamin B12, Auxin and IAA. Further, the chemical fertilizers particularly nitrogen along with farm yard manure and vermicompost after being taken up during growth period resulted quick cell formation and elongation which might have increased the height of plant. These results corroborate the findings of Manivannan and Singh (2004), Abou *et al.* (2004), Bhardwal *et al.* (2007), Raghav and Kamal (2007), Mahmud *et al.* (2007) in broccoli crop.

Leaves are the major sight of photosynthesis and act as major source of “sink”. The production of leaf is mainly influenced by both the environment as well as nutrition. The number of leaves per plant showed significant variation due

to various levels of organic and inorganic fertilizers. The combined application of 100% NPK with biofertilizers and organic sources resulted in maximum production of leaves in broccoli crop as observed in the trials. Similar positive effect was also reported in broccoli crop by Abou *et al.* (2006), Bhardwal *et al.* (2007), Raghav and Kamal (2007). Mahmud *et al.* (2007)

The girth of stem was also influenced by the application of chemical fertilizers, bioinoculants and organic sources. All these influenced to increase the girth of the stem in a positive manner than other treatments where chemical fertilizers were not applied. Application of 100% NPK along with biofertilizers and organic sources also increased the stem girth of the plant to remain upright and hold the curd in right manner. Present result is in confirmation with the results of Thakur *et al.* (1991), Jana and Mukhopadhyay (2001) and Velmurugan *et al.* (2008) in cauliflower.

Leaf area expansion is one of the indications of response of growth factor in many of the nutritional investigation and is also a direct indicator of photosynthetic potentiality of a plant. Application of 100%NPK with bio-fertilizers as well as organic manures as observed from the investigation had significant effect on the increasing leaf area than the control. The chemical fertilizers with bio-inoculants along with organic manures have significantly influenced the leaf area which was superior than other treatment combinations. A similar result was also observed by Thakur *et al.* (1991), Jana & Mukhopadhyay (2001) and Velmurugan *et al.* (2008) in cauliflower.

The days taken for curd initiation as well as maturity have been influenced significantly by the application of 100%NPK with bio-fertilizers along with organic manures over control and other treatments. The initiation of the curd took place within a short period which influenced the early maturity and thereby the investigation was quicker. All the required nutrients necessary

for curd development was available to the plant by combined application of chemical fertilizers + biofertilizers and organic manures which facilitated for the development of the curd in a faster rate and thereby the marketable maturity was earlier. In other cases the availability of the nutrients might have created problem for the late marketable maturity of the curd. The result is in confirmation with the results of Thakur *et al.* (1991), Janna and Mukhopadhyay (2001), Kadam *et al.* (2006) and Supe & Marbhal (2008) in cabbage. Janna and Mukhopadhyay (2001) in cauliflower,

Curd weight as well as curd diameter were found to be significantly influenced with respect to the combined effect of 100% NPK with biofertilizers and FYM + vermicompost as organic source over other treatments (Plate 6, 7, 8, 9). There was an increase in curd weight with increasing dose of NPK along with biofertilizers and organic manures which might have favoured the production as well as accumulation of prepared food. Thereby, increasing the individual curd weight. Similar results were also observed by Singh and Naik (1993), Swaroop *et al.* (1999) in cauliflower, Chatterjee *et al.* (2005), Maurya *et al.* (2008) in broccoli crop.

Application of different levels of NPK in combination with biofertilizers and organic manures increase the yield of fresh curd and ultimately yield per hectare which was in an increasing order with that of increase in the dose of NPK combined with biofertilizers and organic manures. Maximum yield (139.49q/ha) was obtained with use of recommended dose of chemical fertilizers with biofertilizers and organic manures, which was significantly higher than other treatments including control. The increase in yield might have been due to performance of the vegetative growth which might have influenced in the production of more amount of carbohydrates ultimately accumulated in the form of curd and thereby, increase the yield. The increase

in yield may be the solubilization effect of the nutrients as well as chelating effect of bio-fertilizers on metals, thereby, the availability of essential nutrients get increased. The result is in accordance with Wang *et al.* (1997), Sharma and Sharma (1999), Sanderson and Ivany (1999), Sharma (2000), Brahma *et al.* (2002), Magd *et al.* (2005), Feller and Fink (2005), Chatterjee *et al.* (2005), Brahma and Phookan (2006), Ranawah *et al.* (2008) and Maurya *et al.* (2008), who had worked in broccoli.

There was a significant difference among different treatments which was recorded and presented in table 4.10c with respect to plant yield after the harvest of the curd. Maximum plant yield (169.73 q/ha) was recorded by the application of 100%NPK with bio-fertilizers and organic manures, which was found to be significantly superior than other treatment combinations. The increase in plant yield might be due to the availability of different nutrients to the plant which might have expressed in the vegetative growth and thereby, the plant weight has increased after the harvesting of the curd. The growth hormones released by the bio-fertilizers might have influenced in vegetative growth and thereby increasing the individual plant yield after the harvest of the curd. Similar results were also recorded with Thakur *et al.* (1991) in cauliflower, Manivannan and Singh (2004) in broccoli.

Nutrient absorption by the crop under different treatments being influenced by integrated nutrient management practices resulted in higher uptake thereby, recording higher recoveries. Not only the optimal doses of nutrients over suboptimal doses but also lone integration of bio inoculants over lone organic manures application and mostly integration bioinoculants and organic manures with inorganic nutrients increase the recoveries of the nutrients. Integrated nutrient management practices not only yielded higher with quality

produce but also generated sizable income from the crop (Rs.168047 profit/ha for an investment of Rs 41188 /ha with benefit : cost ratio of 5.08:1)

Application of organic fertilizers as well as biofertilizers with organic manures has increased the productivity of broccoli crop as observed in the investigation carried out in 2008-09 and 2009-10 (Plate 10). Chemical fertilizers particularly Nitrogen may be available to the plant in some quantity but the major portion may leach where P and K will remain in bound form in the soil, which will be gradually available to the crop. Biofertilizers act as a chelating agent for different nutrients except N which will be made available in sufficient quantity to the plant which in turn utilized and produced maximum yield. The highest uptake value of nutrients with respect to NPK were recorded by applying 100% NPK combined with biofertilizers and organic manures were applied to broccoli crop Schuphan (1974) reported that efficiency of inorganic fertilizers were pronounced when they were applied combindly with biofertilizers/organics. The maximum availability of NPK individually or synergistically resulted increased vegetative growth which was reflected in terms of foliage production, plant height and ultimately increases in yield. This result confirmed the earlier worked of Evaraats *et al.* (1997) in broccoli, Sable and Bharna (2007) in cauliflower.

Application of inorganic fertilizers mixed with bio-fertilizers in presence of organic manure has increased the productivity of broccoli as observed in the investigation. Nutrients particularly Ca, Mg, S were readily available to the plant as per the requirement. The bio-fertilizers which acted as a chelating agent whereby different nutrients made available to the plant which was utilized properly and produce maximum yield. The highest uptake value with respect to Ca, Mg, S were recorded when 100% NPK

combined with bio-fertilizers and organic manures (vermicompost) applied to the broccoli crop. The maximum availability of major nutrients including Ca, Mg, and S individually or synergistically resulted in increase the vegetative growth and finally the yield. Similar positive results were also found by Sharma & Chandra (2004) in cauliflower.

Not only higher production but also the high quality produce are essential for healthy and wholesome living. The quality of the produce is generally regulated by proper nutrition of crops. Application of different nutrients has exhibited the production of maximum amount of ascorbic acid, reducing sugar and total sugar where maximum amount of organic manures were applied. Highest quantity of these quality parameters were recorded when bio fertilizers were mixed with organic manures like farmyard manure and vermicompost. However, 100%NPK with biofertilizers along with organic manures also remained at par with the treatments where organic manures were applied. Application of only organic manures in presence of biofertilizers fascilated the availability different nutrients which help in the production of ascorbic acid, sugars (reducing and total sugar) thereby, improving the quality of the curd. The results corroborate the findings of Lisiewska and Kmiecik (1996), Wang *et al.*(1997), Babik *et al.* (2002), Chatterjee *et al.* (2005), Sanwal *et al.* (2005), Magd *et al.* (2005) and Raghav and Kamal (2007) in broccoli.

Thus among the treatments tried highest yield of 139.49 q/ha (pooled) was found when 100% NPK (150:45:80 kg/ha) was applied along with bio-fertilizers in presence of organic manures (FYM@ 5t/ha + vermicompost @ 2.5 t/ha) in broccoli crop tried in two consecutive years i.e., 2008-09 and 2009-10.

