Use of pesticides in agriculture is inevitable. However, the indiscriminate use of pesticides leads to the accumulation of these chemicals in the environment and thereby disturbs the soil biological ecosystem. The continuous use of pesticides in turn affect the rhizospheric microorganisms that include the nitrogen fixing and phosphate solubilizing microorganisms and also the growth and yields of various agricultural crops. To evaluate the effect of agrochemicals, pesticides belonging to three different classes viz. insecticide, herbicides and fungicide were used. In the present investigation, the effect of agrochemicals on nodule bacteria (Mesorhizobium ciceri) isolated from chickpea nodules, non symbiotic microorganism (Azotobacter chroococcum) and phosphate solubilizing bacteria (PSB) in culture media (liquid and solid medium) was determined. Additionally, a commonly grown legume, chickpea (Cicer aritinum L) and cereal, wheat (Triticum aestivum L) were subjected to pesticide applications in order to assess their effect on overall growth of these crops.

The results indicated that all agrochemicals at 500-2500 μg ml⁻¹ in general, showed a varied response viz. inhibitory, stimulatory or no effect towards the N₂ fixing and P solubilizing bacteria in two culture medium (liquid and solid agar media). However, insecticides, fungicides and herbicides at ≥ 2500 μg ml⁻¹ drastically reduced the growth of N₂ fixing and P solubilizing bacteria. Isoproturon and 2,4-D at 500 μg ml⁻¹ significantly stimulated the growth of selected PSB in both mediums whereas the same concentrations of fluchloralin significantly improved the growth of all Azotobacter chroococcum strains in liquid culture medium. At higher levels (10000 μg ml⁻¹), each agrochemical completely inhibited the growth of Azotobacter chroococcum. In addition, 5000 μg ml⁻¹ of thiram and zaptan also completely inhibited the growth of Azotobacter chroococcum in both mediums. At 10000 μg ml⁻¹, phorate completely inhibited the growth
of Mesorhizobium ciceri strains in agar medium whereas dimethoate, 2,4-D, carbendazim and thiram reduced the growth of RC-3 while RC-18 inhibited was completely inhibited by malathion at the same rates of applications. Dimethoate, malathion, pendimethalin and fluchloralin at 10000 µg ml⁻¹ completely inhibited the growth of each strains of PSB except PSB 19C and PSB-III in agar medium. A few strains of PSB were also completely inhibited by some pesticides like malathion, endosulfan and phorate at 5000 µg ml⁻¹.

The effect of various agrochemicals at three different levels (ND, 2D and 10D) on the changes of soil microflora like aerobic bacteria, Azotobacter sp. fungi, cellulolytic and lignolytic bacteria in sandy clay loam soil was also investigated. Our results showed that pesticides when applied at rates approximating those with field applications generally did not have adverse effect on beneficial soil microorganisms.

Agrochemicals at 10D in general, also showed no deleterious effect on any group of microflora during 7 and 70 d of incubations. Besides, 10D of 2,4-D, isoproturon pendimethalin, captan and thiram generally did not affect the growth of aerobic bacteria at any incubation periods. Effect of malathion and endosulfan on Azotobacter, 2,4-D on fungi and isoproturon on cellulolytic bacteria with the same rates at any incubation periods usually was non-significant. Interestingly 2,4-D at 10D stimulated the growth of Azotobacter in soil at each incubation periods. Among the soil microorganisms examined, lignolytic bacteria was found most sensitive to all pesticide tested. However, thiram was found most toxic to all soil microorganisms followed by phorate and endosulfan.

The results obtained on the effect of various agrochemicals on beneficial soil microflora in vitro prompted us to evaluate the effect of these products on chickpea and wheat under pot-house-environment. In the present study, agrochemicals that included insecticides, herbicides and fungicides when used at normal and two times more than
recommended rates did not affect the growth and dry matter production negatively rather stimulated the growth and dry matter production of chickpea and wheat crops. However, yield attributes was significantly affected than growth and dry matter production where some of the herbicides i.e. pendimethalin and fluchloralin at normal rates adversely affected the seed yields of chickpea crop. Among all agrochemicals tested, herbicide was found most phytotoxic than fungicides and insecticides. Interestingly, malathion and dimethoate at 10 D improved the plant growth and dry matter. Among both crops, wheat was found generally most sensitive than chickpea.

In the present study, influence of agrochemicals on nodulation of chickpea plant was studied at 30 and 45 days. Our findings clearly showed that the selected agrochemicals differed significantly in their capacity to affect the nodulation and nitrogen fixation. The effect of these selected chemicals on nodulation of chickpea varied from chemicals to chemicals, but was concentrations dependent. In general, the effect of these chemicals on chickpea nodulation was more pronounced at 45 d than 30 d or control plants. At recommended and two times more than normal rates, all agrochemicals in general, improved the _Rhizobium_ chickpea nodulation. Our results indicated that herbicides and fungicides were more phytotoxic towards nodulation as compared to insecticides and therefore, the order of toxicity determined was herbicides > fungicides > insecticides.

Nutrient status of the plant is one of the most important attribute employed to assess the uptake of nutrients by plants and their availability in the soil. Therefore, N, P and K were determined at 30, 45 and at harvest in chickpea and at harvest only in wheat. The nutrient uptake pattern of both chickpea and wheat were generally greater with lower concentrations of all groups of agrochemicals as compared to their agrochemicals free control or absolute control. However, higher concentration (10 D) in general, adversely affected the N.P.K. content in shoots of chickpea and wheat plants.
The chlorophyll content in chickpea as influenced by pesticides application was studied at three stages (40, 60 and 90 days) of plant growth. Among the three stages of crop development, the chickpea plants showed greater chlorophyll content at 60 days. The effect of three concentrations each of insecticide, herbicide and fungicide on chlorophyll content differed significantly. In general no, appreciable changes in the chlorophyll content of chickpea at 40 days of plant growth was determined. Chlorophyll content at 10 D of each pesticide was however, adversely affected. In contrast, the 10 D of malathion improved the chlorophyll content at 40 days of plant growth. The chlorophyll content was found most affected at 60 days followed by 90 and 40 days.

In this study, since pesticide produced only temporary and minor side effects on soil microorganisms, plant growth, development and yields, when used at normal rates we may conclude that there can not be agronomically significant effects of these chemicals on soil fertility. However, the continued use of these agrochemicals at rates higher than the recommended rates may result in any permanent disturbance of the biological equilibrium in soil and possibly lead to the eventual loss of soil fertility. Careful attention to the rates of application and selection of pesticides may therefore, minimize the potential hazardous effects on soil microorganisms and probably soil fertility.