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# Effect of Biofertilizer and Micronutrients on Yield of Chickpea

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**A B S T R A C T**

A field experiment was conducted at the Agriculture farm, Institute of agriculture, sriniketan, Visva-Bharati, West Bengal, India, during *rabi* season of 2014-2015 and 2015-2016. The experiment was laid out in randomized block design with three replications, assigning 24 treatments consisting of three levels of Zinc (10, 20 and 30 kg/ha), Boron (0.5 and 1 kg/ha with one foliar spray @ 0.5%) and Molybdenum (0.5, 1 and 1.5 kg/ha) with and without Rhizobium inoculation. Grain yield increased with micronutrient application and the highest grain yield (977.2 kg/ha) was obtained where *Rhizobium* was applied along with micronutrients i.e. RDF + Rhizo. + Zn (20kg/ha) + B (0.5kg/ha) + Mo (1kg/ha). *Rhizobium* and Micronutrient application also influenced significantly the stover yield and the highest stover yield (2144.3 kg/ha) was recorded in the same treatment where we got the highest grain yield. These result shows that application of micronutrients upto second level along with *Rhizobium* inoculation was more effective for growth and yield of chickpea. Micronutrients and biofertilizer application also influenced significantly the yield attributes i.e., pods per plant, plant height except seed per pod and test weight.

## Introduction

Chickpea (*Cicer arietinum* L.) is the fourth largest grain legume crop in the world, with a total production of 13.1 M tonnes from an area of 13.5 M ha and productivity of 0.97 tonnes/ha (FAO STAT 2013). India is one of the important chickpea growing countries in Asia with an area of 9.6 M. ha and production of 8.83 M tonnes with a productivity of 920 kg per ha (FAO STAT, 2013). India ranked first in area and production in the world. Chickpea also plays an important role in sustaining soil productivity by improving its physical, chemical and biological properties and trapping atmospheric nitrogen in their root nodules (Ali and Kumar, 2005). Because of its nutritional benefits chickpea cultivation is gaining importance not only in India, but also all over the world. Nutritive value of chickpea is Protein (18-22%), Carbohydrate (61-62%), Fat (4.5 %), Calcium (280 mg/100 g) Iron (12.3 mg/100 g) and Phosphorus (301 mg/100 g). Generally *Rhizobium* inoculation increased plant growth, yield and yield components and nitrogen fixation in Chickpea (Fatima, *et al.*, 2008). Brahmaprakash and Sahu (2012) says that Chickpea play essential role in ensuring nutritional security and environmental safety as they have inbuilt mechanism to fix atmospheric nitrogen. In legume crop *Rhizobium* symbiosis is an important facet of symbiotic nitrogen fixation which is exploited to benefit agriculture and its sustainability. Micronutrients play an important role in increasing yield of chickpea. Micronutrients also play an important role in increasing yield of pulses and oilseed legumes through their effects on the plant itself and on the nitrogen fixing symbiotic process. Nutrients depletion particularly micronutrients in the soil is increasing. Micronutrient deficiency problems are also aggravated by the high demand of modern crop cultivars. Micronutrients application increase crop yields have been reported in many parts of the world. There is a direct relationship between micronutrients level in crops and human health mainly Zn and B. Graham *et al.*, (2001) reported that more than 3 billion people in the world suffer from Zn deficiencies. Major dietary nutritional disorder of the poor households of a country who heavily subsist on rice is Zn deficiency (Holtz and Brown, 2004). Approximately 30% children in the world have stunted growth and the main reason is micronutrient (Zn) deficiency (Brown, 2007). Under deficient condition pulse crops respond well to application of micronutrients like Zn, B and Mo. Among the various micronutrients, zinc has assumed greater significance due to wide occurrence of its deficiency in different agro climatic regions of the country and spectacular response of field and fruit crops to its application. Chickpea is mainly cultivated as a rainfed crop and water stress often affects both the productivity and the yield stability of the chickpea. Rainfed soils are generally degraded with poor native fertility. Micronutrients play an important role in increasing legume yield through their effects on the plant itself, on the nitrogen fixing symbiotic process and the effective use of the major and secondary nutrients, resulting in high legume yields. Zinc is the main micronutrient that limits chickpea productivity (Ahlawat *et al.,* 2007).

The availability of molybdenum is low in acidic soils. The availability of micronutrients is the greatest in the very slight to medium acid range soil except Molybdenum. Ahlawat *et al.*, (2007) reported that each tonne of chickpea grain removes 38 gram of Zn from the soil and it is estimated that 35 g of B and 1.5 g of Mo are removed from the soil as well. Zn deficiency is perhaps the most widespread deficiency among micronutrients (Roy *et al.*, 2006; Ahlawat *et al.*, 2007) and it is common among all chickpea growing regions of the world. Chickpea is generally considered as sensitive to Zn deficiency (Khan, 1998), although there are differences in sensitivity to Zn deficiency between varieties (Khan, 1998; Ahlawat *et al.*, 2007).

A comparison between several crop species has shown that chickpea is more sensitive to Zn deficiency than cereal and oil seeds (Tiwari and Pathak, 1982). Depending on soil type the critical Zn concentrations in soils vary from 0.48 mg/kg to 2.5 mg/kg (Ahlawat *et al.*, 2007) and according to Ankerman and Large (1974) if Zn concentration in soil is less than 1.1 mg/kg that means soil indicated the low availability of Zn (DTPA extraction). Zn deficiency decreases crop yield and delays crop maturity. Zn deficiency reduces nodulation and nitrogen fixation (Ahlawat *et al.*, 2007) and according to Khan *et al.*, (2004) Zn deficiency also reduces water use and water use efficiency and which contributes to reduce in crop yield.

Boron which also limits chickpea productivity but it is a less important factor than Zn (Ahlawat *et al.,* 2007). According to Srivastava *et al.,* (1997) some regions of acidic soils B has been shown to be a major reducer of chickpea yields. Application of B in chickpea crop responses higher in comparison with others cereals crop (Wankhade *et al.,* 1996); although differences between chickpea cultivars concerning B deficiency have also been observed (Ahlawat *et al.,* 2007). According to Ahlawat *et al.,* (2007) the application of B is important when the concentration of B in the soil is less than 0.3 mg/kg. Soils have low B availability when the concentration of B in the soil is less than 0.6 mg/kg (hot water extraction) (Ankerman and Large 1974) and according to Sillanpää (1972) the soil may have a B deficiency when the concentration in the soil is less than 0.5 mg/kg depending on the conditions i.e., the extraction time and the soil. B deficiency also causes poor podding, flower drop and subsequently chickpeas poor yields (Srivastava *et al.,* 1997). Boron may cause yield losses up to 100% (Ahlawat *et al.,* 2007).

According to Sims, (2000) total Molybdenum content in soil can vary from 0.2 to 5.0 mg/kg but in the soil Mo is largely unavailable, usually less than 0.2 mg/kg of Mo has been reported to be soluble (Sillanpää, 1972). Ankerman and Large (1974) reported that soils have low Mo availability when the concentration of Mo in the soil is less than 0.11 mg/kg (ammonium acid oxalate). If soil have Mo deficient then chickpea produced lesser number flowers, smaller flower size and many of them fail to open or to mature and finally this leads to decreases grain yield (Ahlawat *et al.,* 2007). Roy *et al.,* (2006) says that Mo is directly related to N fixation by legumes. When the pH of the soil is very slight to medium acid range then the availability of Mo is very low. According to Sims (2000) Mo deficiency is very common in acidic soils especially in crops that are very sensitive to low concentrations of Mo such as legumes. Soil and foliar application are effective practices for the implementation of some micronutrients (Roy *et al.,* 2006). This work was conducted to determine the effect of Zn. B, Mo and *Rhizobium* application on growth and yield of chickpea.

## Materials and Methods

Field experiment during rabi (November to March) seasons of 2014-2015 and 2015-2016 was conducted at agriculture farm of Visva-Bharati, Sriniketan, West Bengal. Experimental site was situated at 23°39’ N latitude and 87°42’ E longitude with an average altitude of 58.9m above mean sea level under sub humid semi-arid region of West Bengal. The soil of experimental site was silty loam in texture containing pH 4.7and bulk density 1.33 g/cc.

Treatment combinations was arranged in a randomized block design replicated three times with three levels of Zinc (10, 20 and 30 kg/ha), Boron (0.5 and 1 kg/ha with one foliar spray @ 0.5%) and Molybdenum (0.5,1 and 1.5 kg/ha) with and without *Rhizobium* inoculation. For fertilizer application we use Zinc sulphate for Zn, Borax for B and Ammonium molybdate for Mo. The chickpea cultivated variety Mahamaya-1 that is 120 days duration variety was shown at 30cm x 15cm spacing with 4m x 3m plot size. Before sowing some seeds were inoculated with *Rhizobium* for specific treatments at 20g per kg seed. Yield of grain and stover was estimated from a unit sample area of 1 $m^2$ in each plot. The plant and seed samples collected after harvest of the crop for analysis of different parameters. After this plant and seed samples was incubated in oven at 60º temperature for further analysis like test weight etc. Soil samples was collected from 0-15 cm depth from chickpea grown research field from each plot (in three zig-zag manner for each plot for one sample) after harvesting of crop. Air dried soil sample were ground to pass through 2.0mm mesh sieve. The result of two years data obtained more or less similar and after that the data of two years was pooled and statistically analyzed by applying analysis of variance (ANOVA) technique for final result. The differences among treatments were compared by applying 'F' test of significance at 5 per cent level of probability.

## Results and Discussion

Grain and stover yield of chickpea was significantly influenced with increasing levels of micronutrients (Table 1). The application of different micronutrients treatments with or without *Rhizobium* inoculation increase the grain and stover yield by chickpea significantly over control. The combined application of Zn, B, Mo with *Rhizobium* inoculation gave significantly higher grain yield as compared to application of any one, two or three micronutrients without seed inoculation. Highest seed yield (977.2 kg/ha) was recorded with treatment receiving combine application of all three micronutrients along with biofertilizer upto second level of fertilizer application i.e. RDF + *Rhizobium* + Zn (20 kg/ha) + B (0.5 kg/ha) + Mo (1 kg/ha). Straw yield was also recorded highest (2144.3 kg/ha) in same treatment (Fig. 1 and 2).

**Table.1** Effect of biofertilizer and micronutrients on grain and stover yield (kg/ha) of chickpea

| Treatments | Grain yield | | | Stover yield | | |
|---|---|---|---|---|---|---|
| | Year 1 | Year 2 | Pooled | Year 1 | Year 2 | Pooled |
| **Control** | 636.3 | 655.3 | 645.8 | 1387.3 | 1441.3 | 1414.3 |
| **RDF (25:50:25)** | 676.3 | 684.3 | 680.3 | 1478.0 | 1504.3 | 1491.2 |
| **RDF + $Zn_{10}$** | 915.0 | 757.3 | 836.2 | 2000.7 | 1661.0 | 1830.8 |
| **RDF + $B_{0.5\%}$** | 790.0 | 881.7 | 835.8 | 1727.0 | 1939.7 | 1833.3 |
| **RDF + $Mo_{0.5}$** | 791.0 | 869.7 | 830.3 | 1733.0 | 1912.7 | 1822.8 |
| **RDF + Rhizo** | 821.0 | 770.7 | 795.8 | 1794.7 | 1695.0 | 1744.8 |
| **RDF + Rhizo + $Zn_{10}$** | 873.7 | 855.7 | 864.7 | 1910.7 | 1881.3 | 1896.0 |
| **RDF + Rhizo + $B_{0.5\%}$** | 875.7 | 777.0 | 826.3 | 1915.0 | 1706.7 | 1810.8 |
| **RDF + Rhizo + $Mo_{0.5}$** | 793.7 | 849.7 | 821.7 | 1734.7 | 1864.7 | 1799.7 |
| **RDF + Rhizo + $Zn_{10}$ + $B_{0.5\%}$ + $Mo_{0.5}$** | 892.3 | 881.3 | 886.8 | 1951.7 | 1935.0 | 1943.3 |
| **RDF + $Zn_{20}$** | 906.0 | 770.0 | 838.0 | 1982.3 | 1692.3 | 1837.3 |
| **RDF + $B_{0.5}$** | 804.0 | 852.3 | 828.2 | 1771.3 | 1874.0 | 1822.7 |
| **RDF + $Mo_1$** | 850.3 | 871.7 | 861.0 | 1862.3 | 1917.7 | 1890.0 |
| **RDF + Rhizo + $Zn_{20}$** | 847.0 | 862.0 | 854.5 | 1852.0 | 1338.3 | 1595.2 |
| **RDF + Rhizo + $B_{0.5}$** | 782.3 | 773.7 | 778.0 | 1709.0 | 1697.3 | 1703.2 |
| **RDF + Rhizo + $Mo_1$** | 838.0 | 851.7 | 844.8 | 1834.3 | 1876.0 | 1855.2 |
| **RDF + Rhizo + $Zn_{20}$ + $B_{0.5}$ + $Mo_1$** | 976.7 | 977.7 | 977.2 | 2138.7 | 2150.0 | 2144.3 |
| **RDF + $Zn_{30}$** | 913.0 | 776.7 | 844.8 | 1996.0 | 1707.3 | 1851.7 |
| **RDF + $B_1$** | 944.0 | 894.3 | 919.2 | 2063.3 | 1970.3 | 2016.8 |
| **RDF + $Mo_{1.5}$** | 790.3 | 812.0 | 801.2 | 1727.3 | 1782.0 | 1754.7 |
| **RDF + Rhizo + $Zn_{30}$** | 795.0 | 961.7 | 878.3 | 1739.0 | 2112.3 | 1925.7 |
| **RDF + Rhizo + $B_1$** | 876.0 | 829.0 | 852.5 | 1914.3 | 1820.7 | 1867.5 |
| **RDF + Rhizo + $Mo_{1.5}$** | 830.3 | 902.3 | 866.3 | 1817.0 | 1984.0 | 1900.5 |
| **RDF + Rhizo + $Zn_{30}$ + $B_1$ + $Mo_{1.5}$** | 816.0 | 862.0 | 839.0 | 1784.0 | 1897.0 | 1840.5 |
| **SEm±** | 23.2 | 13.3 | 13.9 | 51.2 | 122.2 | 68.8 |
| **CD at 5%** | 66.0 | 37.8 | 39.7 | 145.9 | 347.8 | 196.0 |

**Table.2** Effect of biofertilizer and micronutrients on yield attributes of chickpea

| Treatments | Pod/plant | | | Seed/pod | | |
|---|---|---|---|---|---|---|
| | Year 1 | Year 2 | Pooled | Year 1 | Year 2 | Pooled |
| **Control** | 31.3 | 31.7 | 31.5 | 1.00 | 1.00 | 1.00 |
| **RDF (25:50:25)** | 32.0 | 37.7 | 34.8 | 1.00 | 1.00 | 1.00 |
| **RDF + $Zn_{10}$** | 36.7 | 40.3 | 38.5 | 1.33 | 1.33 | 1.33 |
| **RDF + $B_{0.5\%}$** | 42.3 | 39.3 | 40.8 | 1.00 | 1.33 | 1.17 |
| **RDF + $Mo_{0.5}$** | 37.0 | 42.7 | 39.8 | 1.33 | 1.67 | 1.50 |
| **RDF + Rhizo** | 39.0 | 41.7 | 40.3 | 1.33 | 1.00 | 1.17 |
| **RDF + Rhizo + $Zn_{10}$** | 38.3 | 37.7 | 38.0 | 1.33 | 1.33 | 1.33 |
| **RDF + Rhizo + $B_{0.5\%}$** | 41.7 | 41.0 | 41.3 | 1.00 | 1.33 | 1.17 |
| **RDF + Rhizo + $Mo_{0.5}$** | 36.3 | 42.3 | 39.3 | 1.33 | 1.33 | 1.33 |
| **RDF + Rhizo + $Zn_{10}$ + $B_{0.5\%}$ + $Mo_{0.5}$** | 34.3 | 45.7 | 40.0 | 1.00 | 1.67 | 1.33 |
| **RDF + $Zn_{20}$** | 39.0 | 41.3 | 40.2 | 1.00 | 1.00 | 1.00 |
| **RDF + $B_{0.5}$** | 36.7 | 44.3 | 40.5 | 1.33 | 1.00 | 1.17 |
| **RDF + $Mo_1$** | 37.3 | 47.3 | 42.3 | 1.33 | 1.67 | 1.50 |
| **RDF + Rhizo + $Zn_{20}$** | 37.3 | 43.3 | 40.3 | 1.33 | 1.00 | 1.17 |
| **RDF + Rhizo + $B_{0.5}$** | 39.7 | 40.7 | 40.2 | 1.33 | 1.00 | 1.17 |
| **RDF + Rhizo + $Mo_1$** | 37.0 | 45.3 | 41.2 | 1.00 | 1.67 | 1.33 |
| **RDF + Rhizo + $Zn_{20}$ + $B_{0.5}$ + $Mo_1$** | 45.7 | 50.7 | 48.2 | 1.67 | 1.67 | 1.67 |
| **RDF + $Zn_{30}$** | 38.3 | 45.0 | 41.7 | 1.00 | 1.33 | 1.17 |
| **RDF + $B_1$** | 39.3 | 52.3 | 45.8 | 1.33 | 1.00 | 1.17 |
| **RDF + $Mo_{1.5}$** | 37.7 | 46.0 | 41.8 | 1.33 | 1.67 | 1.50 |
| **RDF + Rhizo + $Zn_{30}$** | 37.0 | 40.3 | 38.7 | 1.00 | 1.00 | 1.00 |
| **RDF + Rhizo + $B_1$** | 39.0 | 44.0 | 41.5 | 1.00 | 1.00 | 1.00 |
| **RDF + Rhizo + $Mo_{1.5}$** | 37.0 | 45.3 | 41.2 | 1.00 | 1.67 | 1.33 |
| **RDF + Rhizo + $Zn_{30}$ + $B_1$ + $Mo_{1.5}$** | 42.7 | 43.7 | 43.2 | 1.67 | 1.67 | 1.67 |
| **SEm±** | 1.29 | 1.66 | 1.12 | NS | NS | NS |
| **CD at 5%** | 3.68 | 4.74 | 3.19 | NS | NS | NS |

**Table.3** Effect of biofertilizer and micronutrients on plant height and test weight

| Treatments | Plant height (cm) | | | Test weight (100 seed) (g) | | |
|---|---|---|---|---|---|---|
| | Year 1 | Year 2 | Pooled | Year 1 | Year 2 | Pooled |
| **Control** | 33.7 | 35.3 | 34.5 | 9.93 | 9.85 | 10.14 |
| **RDF (25:50:25)** | 39.7 | 37.0 | 38.3 | 9.66 | 9.86 | 9.72 |
| **RDF + $Zn_{10}$** | 38.0 | 37.7 | 37.8 | 9.88 | 9.92 | 9.92 |
| **RDF + $B_{0.5\%}$** | 37.0 | 37.3 | 37.2 | 10.20 | 9.84 | 10.12 |
| **RDF + $Mo_{0.5}$** | 36.0 | 37.3 | 36.7 | 9.66 | 10.17 | 9.93 |
| **RDF + Rhizo** | 34.3 | 38.7 | 36.5 | 10.09 | 9.99 | 10.05 |
| **RDF + Rhizo + $Zn_{10}$** | 30.3 | 35.3 | 32.8 | 10.10 | 10.04 | 10.13 |
| **RDF + Rhizo + $B_{0.5\%}$** | 36.0 | 35.7 | 35.8 | 10.45 | 10.32 | 10.38 |
| **RDF + Rhizo + $Mo_{0.5}$** | 34.3 | 38.3 | 36.3 | 10.51 | 10.26 | 10.36 |
| **RDF + Rhizo + $Zn_{10}$ + $B_{0.5\%}$ + $Mo_{0.5}$** | 39.3 | 39.0 | 39.2 | 9.89 | 9.76 | 9.80 |
| **RDF + $Zn_{20}$** | 31.0 | 39.7 | 35.3 | 9.62 | 9.68 | 9.68 |
| **RDF + $B_{0.5}$** | 31.3 | 40.0 | 35.7 | 10.12 | 10.05 | 10.06 |
| **RDF + $Mo_1$** | 29.7 | 39.3 | 34.5 | 10.39 | 10.14 | 10.02 |
| **RDF + Rhizo + $Zn_{20}$** | 39.3 | 34.3 | 36.8 | 9.71 | 10.20 | 9.67 |
| **RDF + Rhizo + $B_{0.5}$** | 32.7 | 39.3 | 36.0 | 9.66 | 10.11 | 9.88 |
| **RDF + Rhizo + $Mo_1$** | 34.7 | 33.0 | 33.8 | 9.67 | 10.11 | 9.87 |
| **RDF + Rhizo + $Zn_{20}$ + $B_{0.5}$ + $Mo_1$** | 40.3 | 42.0 | 41.2 | 9.61 | 10.07 | 9.86 |
| **RDF + $Zn_{30}$** | 31.7 | 35.3 | 33.5 | 9.73 | 9.50 | 9.34 |
| **RDF + $B_1$** | 36.7 | 32.3 | 34.5 | 9.38 | 9.79 | 9.56 |
| **RDF + $Mo_{1.5}$** | 29.3 | 35.3 | 32.3 | 10.14 | 10.21 | 10.15 |
| **RDF + Rhizo + $Zn_{30}$** | 38.7 | 40.3 | 39.5 | 10.35 | 10.00 | 10.26 |
| **RDF + Rhizo + $B_1$** | 40.3 | 35.0 | 37.7 | 10.45 | 10.64 | 10.57 |
| **RDF + Rhizo + $Mo_{1.5}$** | 37.7 | 34.0 | 35.8 | 9.53 | 9.87 | 9.67 |
| **RDF + Rhizo + $Zn_{30}$ + $B_1$ + $Mo_{1.5}$** | 35.3 | 36.7 | 36.0 | 9.54 | 9.67 | 9.59 |
| **SEm±** | 1.15 | 1.29 | 0.78 | NS | NS | NS |
| **CD at 5%** | 3.28 | 3.68 | 2.23 | NS | NS | NS |

**Fig.1** Chickpea Global Scenario (2013) - Area

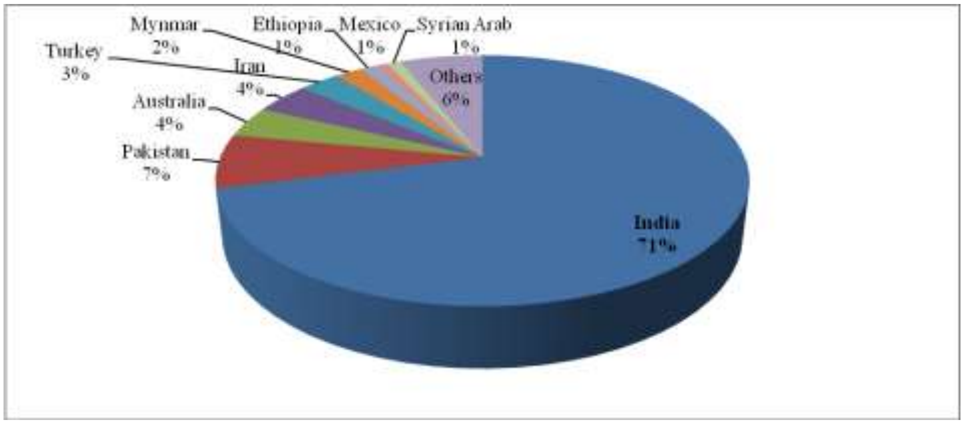
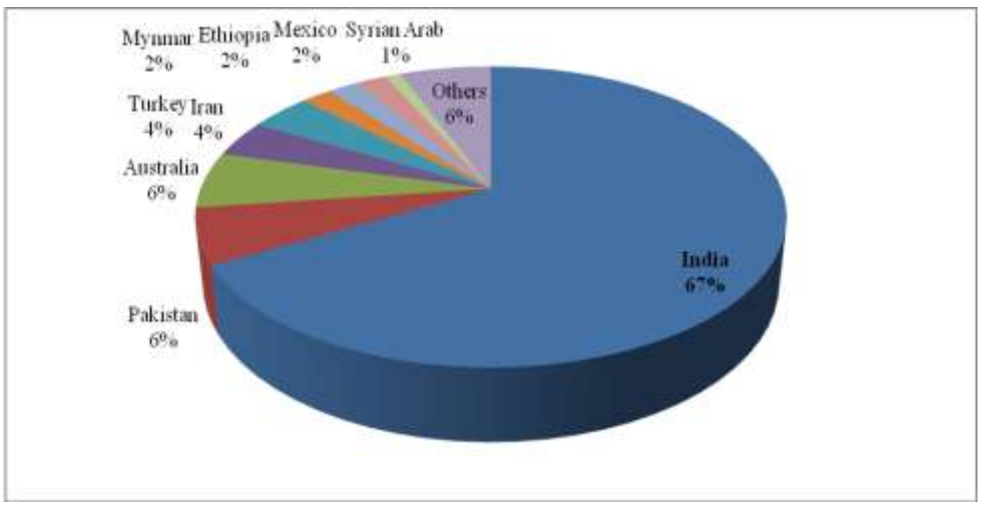
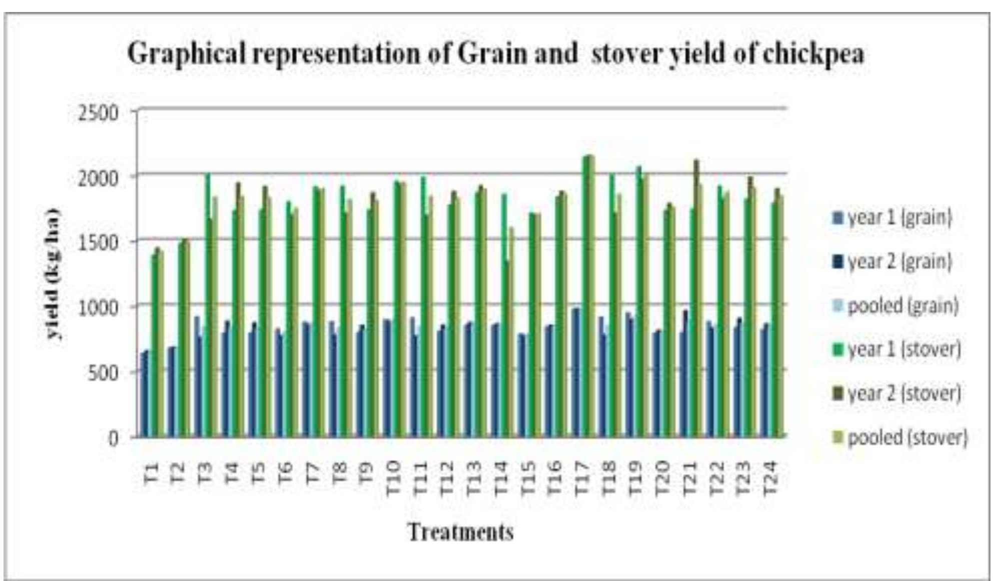



**Fig.2** Chickpea Global Scenario (2013) - Production



These result shows that chickpea is highly responsive crop to micronutrient fertilizer so that application of biofertilizer along with micronutrients particularly Zn. B and Mo enhance the seed and stover yield of chickpea. Same findings also reported by Das *et al.*, (2012) Pal (1986) and Singh *et al.*, (2004) (Table 2).

Highest pods per plant (48.2) was recorded in the treatment where applied RDF + *Rhzobium* + Zn (20 kg/ha) + B (0.5 kg/ha) + Mo (1 kg/ha). These result shows that the combined application of Zn, B, Mo and *Rhizobium* inoculation provides a beneficial effect on number of pods per plant but in case of seed per pod no significant result was observed. Jat and Ahlawat (2004) also reported that the number of pods per plant increased significantly with increasing level of micronutrients. This could be attributed to increased the availability of micronutrients with each successive level of micronutrients and its positive effect on growth attributes and subsequent on yield components. The Zn application was more efficient when it was applied with B and Mo. The number of pods per plant is the most effective yield component and the yield component that is most closely correlated with seed yield. This result was also reported by Valenciano *et al.*, (2010).

Highest plant height (41.2 cm) was obtained in the treatment where applied RDF + *Rhzobium* + Zn (20 kg/ha) + B (0.5 kg/ha) + Mo (1 kg/ha) and the two treatments was at par with this i.e., RDF + *Rhzobium* + Zn (30 kg/ha) and where we applied RDF + *Rhzobium* + Zn (10 kg/ha) + B (0.5%) + Mo (0.5 kg/ha) and the result was 39.5 cm and 39.2 cm respectively. This result shows that second level of micronutrients application with *Rhizobium* application give the highest plant height. This result was also reported by Shil *et al.*, (2007). Test weight result was statistically non significant (Table 3).

In conclusion after all the analysis study revealed that application of biofertilizer along with micronutrients upto second level gave maximum result in most of the parameters. So now we can say that, treatment where we applied RDF + *Rhizobium* + Zn (20kg/ha) + B (0.5kg/ha) + Mo (1kg/ha) was best among the rest treatments. After this we can suggest to the farmers to apply this in their chickpea field for better yield.

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