The Bioscan 11(1): 411-415, 2016 (Supplement on Agronomy)
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
www.thebioscan.in

EFFECT OF BIO AND CHEMICAL FERTILIZERS ON SOIL PROPERTIES, YIELD ATTRIBUTES AND YIELD OF BABY CORN (*ZEA MAYS* L.)

DHARMENDRA MISHRA* AND EUGENIA P. LAL
Department of Biological Sciences, Sam Higginbottom Institute of Agriculture Technology and Sciences, Allahabad, Uttar Pradesh - 211 007
e-mail: m.dharmu03@gmail.com

KEYWORDS
Azotobacter chroococcum
Pseudomonas putida
Bacillus mucilaginosus
Chemical fertilizers
Yield of baby corn

Received on :
15.10.2015

Accepted on :
25.01.2016

***Corresponding author**

ABSTRACT
An experiment was conducted at the research field department of biological sciences sam higginbottom institute of agriculture, technology and sciences, (deemed university) Allahabad, 211007 (U.P). India, during seasons of 2014 -15 to investigate the effect of different bio and chemical fertilizers on soil properties, Yield attributes and Yield of Baby corn with the aim to maintain the soil properties, increase the yield and nutrient value of baby corn by different biofertilizers. The variety sonal F1 hybrid was used as experimental material and treatments consisted of various combinations of biofertilizers *Azotobacter chroococcum, Pseudomonas putida, Bacillus mucilaginosus* and N.P.K fertilizers. Biofertilizers significantly increased soil properties, yield and yield attributing characters. The best treatment identified was based on the mean performance the treatment 6 (@ 50% RDN *Pseudomonas putida + Azotobacter chroococcum* 20g kg^{-1}). Inter action effect of biofertilizers was significant for all character except for potassium. Thus, it indicates that the process of biofertilizers may be better option for soil properties, and yield component of baby corn.

INTRODUCTION

Baby corn (*Zea mays* L.) cultivation is a recent development. It was Thailand in the 1970s that first seriously started cultivating this crop for export. Later other countries like Guatemala, Zambia, Zimbabave and South Africa started cultivation. Today Thailand and china are the world leaders in baby corn production. Baby corn cultivation is a recent development in India. It is becoming popular among the city elite and the processing industry (Ramachandrappa *et al.* 2004). This crop has been developed into a multi dollar business in foreign countries (Thailand, Taiwan, Singapore, Malaysia, USA, Canada and Germany) because of its potential as a value added product for export and a good food substitute. During recent times, its potentiality has been extended to the field of vegetable production (Mugalkhod *et al.* 2011). The optimum amounts of basic elements in the soil cannot be utilized efficiency if nitrogen is deficient in plants. Therefore, nitrogen deficiency or excess can result in reduced maize yield. Application of nitrogen fertilizer Has also been reported to have significant effect on grain yield and quality of maize (Sharifi and Taghizadeh, 2009). Nitrogen play an important role in plant metabolism by virtue of being an essential constituent of structural component of the cell wall and many metabolically active compounds. It is also a constituent of chlorophyll, which is important for harvest of solar energy (Bray, 1983). Use of organic sources along with chemical fertilizers not only conserves moisture and reduces erosion but also increases the nutrients use efficiency, thereby improving the overall productivity of soil (Sinha *et al.,* 2011). Further, Long-term studies being carried out at several locations in India indicated that application of all the needy nutrients through chemical fertilizers have deleterious effect on soil health leading to unsustainable yields (Anand Swarup, 2002). Nitrogen fixers and phosphate solubilizers contribute through biological fixation of nitrogen, solubilization of fixed nutrients and enhanced uptake of plant nutrients (Mane *et al.*, 2000). Soil and crop responded well due to poor resources management during subsequent period, the decline in the crop yield as well as soil health has continued to persist till today. Intensive agricultural practices have resulted in numerous problems like micro nutrient deficiencies, nutrients imbalances, and deterioration of soil health and decline crop yield. No single source of nutrient is capable of supplying plant nutrients in adequate amount and in balanced proportion. Not only this, but also fertilizers are more expensive in developing countries. Therefore, the current trend is to explore the possibility of supplementing chemical fertilizers with organic and Biofertilizers.

Baby corn crop require large quantity of major nutrient like N. P. K for better growth and development ultimately yield of crop. The over use of inorganic fertilizers cause hardness, reduce microbial population in soil, decrease the fertility, there by bringing hazards to human health besides being quite expensive and thereby making the cost of production high. Under such circumstances, biofertilizers may play a major role. Such eco-friendly approach has great potential for soil.

Biofertilizers as the best solution to avoid soil pollution and maintaine the fertility in soil. Hence, the present investigation was undertaken to explore the effect of different biofertilizers and on soil properties, growth and yield of baby corn with the aim to maintaining of soil properties, environmentally safe technology for baby corn production.

MATERIALS AND METHODS

This research was carried out during Rabi season 2014-15, in research field, Department of biological sciences, SHIATS, Allahabad (U.P) Which is located at 25^0 57′N latitude, 87^o 19′ E longitude 98 m altitude above the mean sea level. The soil of the experimental area was sandy loam pH; (7.4) Potentiometry method (Piper, 1966), and available N (244.26 kg ha^{-1}) alkaline potassium permanganate method for nitrogen (Subbiah and Asija, 1956), available P (21.22 kg ha^{-1}) Olsen's method (Olsen, *et al*., 1954) and available K (128.62 kg ha^{-1}) Flame photometry (Jackson, 1973). During late *rabi* 2014 seasons respectively. The experiments was laid out in Randomized block design with three replications on a gross plot size of field is 21.0 x 8.80 m and a net plot size of 9 x 6 m. And the each plot size was of (2 x 2) 4.0 m with distance of 0.45 m between rows and 0.20 m between plants with in a row. 2 times irrigation, fertilizers and other cultural practices were followed to raise a baby corn crop. The treatments included in the experiment were T_0 = Control (without any fertilizers), T_1 = @ Recommended Dose of N.P.K, T_2 = @ 50% of Recommended Dose of nitrogen (RDN). T_3 = @ 50% RDN + *Pseudomonas putida 20g* kg^{-1} seed, T_4 = @ 50% RDN + *Azotobacter chroococcum* 20g kg^{-1} seed, T_5 = @ 50% RDN + *Bacillus mucilaginosus* 20g kg^{-1} seed, T_6 = @ 50% RDN + *Pseudomonas putida* + *Azotobacter chroococcum* 20g kg^{-1} seed, T_7 = @ 50% RDN + *Azotobacter chroococcum* + *Bacillus mucilaginosus* 20g kg^{-1} seed, T_8 = @ 50% RDN + *Bacillus mucilaginosus* + *Pseudomonas putida* 20g kg^{-1} seed. At the time land preparation while as full dose of phosphorus and potassium and half dose of nitrogen was applied as basal dose while remaining nitrogen was applied in two equal split applications at knee high stage and pre-tasseling stage. The source of N, P and K were Urea, Diammonium phosphate and Muriate of potash respectively. All the cultural operations were performed as per the package of practices of baby corn.

Baby corn variety sonal F1 hybrid was used as experimental material. Seed treatment by different biofertilizers *Azotobacter chroococcum* culture this culture containing *Azotobacter chroococcum* were obtained from Department of Plant Pathology and Entomolgy, SHIATS, Allahabad (U.P) The bacterial slurry was prepared and applied as per procedure mentioned below. (i) 200 g of jaggery was dissolved in 200 ml of water. Jaggery solution as per the volume of seed was prepared. (ii) The *Azotobacter chroococcum* culture was throughly mixed for slurry preparation in above solution. (iii) Seeds were treated with this mixture carefully, so that seed coat was not injured and a uniform coating is made. (iv)Treated seeds were dried under shade on gunny bags and then used for sowing. *Pseudomonas putida* culture This culture containing *Pseudomonas putida* were obtained from Department of Plant Pathology and Entomology, SHIATS, Allahabad (U.P) The bacterial slurry was prepared and applied as per procedure mentioned below. (i) 200 g of jaggery was dissolved in 200mL of water. Jaggery solution as per the volume of seed was prepared. (ii) The *Pseudomonas putida* culture was thoroughly mixed for slurry preparation in above solution. (iii) Seeds were treated with this mixture carefully, so that seed coat was not injured and a uniform coating is made. (iv)Treated seeds were dried under shade on gunny bags and then used for sowing. *Bacillus mucilaginosus* culture This culture containing *Bacillus mucilaginosus* were obtained from market source from Ghaziabaad. The bacterial slurry was prepared and applied as per procedure mentioned below. (i) 200 g of jaggery was dissolved in 200 ml of water. Jaggery solution as per the volume of seed was prepared. (ii) The *Bacillus mucilaginosus* culture was thoroughly mixed for slurry preparation in above solution. (iii) Seeds were treated with this mixture carefully, so that seed coat was not injured and a uniform coating is made. (iv)Treated seeds were dried under shade on gunny bags and then used for sowing.

Soil analysis

The soil pH was measured in 1:2.5, soil: water suspensions and other relevant properties

were determined following standard methodologies (Fig. 2).The soil samples were drawn from each experimental unit after harvesting of baby corn and analyzed for available nutrients as per the following methods; alkaline potassium permanganate method for nitrogen (Subbiah and Asija, 1956), Olsen's method for phosphorus (Olsen *et al.,* 1954) and flame photometric method for potash (Jackson, 1973).

Biochemical analysis

The biochemical parameters such as total chlorophyll (Arnon, 1949), protein contents were estimated by following the methods given by (Lowry *et al.*,1951).

Observations on morphological traits were recorded for Five randomly selected plants while as Baby corn yield were recorded on plot basis. The raw data was subjected to appropriate statistical procedure as suggested by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Growth parameters

In general, the growth parameters *viz.,* plant height, Number of leaves per plant; Data related to plant characteristics are presented in Table1. Significant difference was recorded among the treatments with respect to plant height and no of leaves at 15, 30, 45 and 60 days after sowing (DAS). Maximum height (6.19 cm) was recorded in the treatment having @ 50% RDN + *Pesudomonas putida* + *Azotobacter chroococcum* 20g kg^{-1} seed: T_6 and it was on par with the application of @ 50% RDN + *Bacillus mucilaginosus* + *Pseudomonas putida* 20g kg^{-1} seed (T_8: 3.48cm) compared to Control (T_0 : 3.48cm). The increase in growth of baby corn could be attributed to the enhanced nutrient use efficiency in the presence of organic fertilizer. Many research studies have showed that the composed of organic materials release nutrients slowly and may reduce the leaching losses, particularly N (Nevens and Reheul, 2003 and Naveed *et al*. 2008) and showed in table1.

Table 1: Effect of bio and chemical fertilizers on morphological, biochemical and yield of baby corn (*Zeamays* L.)

Treatment	Plant height /plant (cm)				No of leaves/plants				No. of baby corn /plant	Weight of cob with husk(g)	Weight of cob without husk (g)	Cob yield (kg/plot)	Total chlorophyll content (mg/g)	Protein content (g)
	15	30	45	60	15	30	45	60						
T_0	3.48	18.13	38.34	60.24	2.11	2.28	4.08	6.24	1.11	22.34	5.91	1.12	2.43	1.10
T_1	5.33	24.41	63.64	08.86	4.51	5.25	8.95	10.63	2.43	41.45	10.64	1.87	2.72	1.63
T_2	4.17	22.17	56.21	104.53	3.15	6.30	7.33	9.48	1.67.	39.69	8.74	1.69	2.51	1.27
T_3	5.14	24.25	63.43	108.21	4.33	6.30	8.73	10.24	2.31	41.25	10.35	1.70	2.53	1.41
T_4	5.88	25.48	63.82	112.85	4.66	7.17	9.44	11.66	2.53	42.87	10.84	1.91	2.87	1.75
T_5	5.21	24.38	63.53	108.63	4.45	6.36	8.81	10.46	2.35	41.36	10.57	1.71	2.64	1.55
T_6	7.14	28.88	68.14	117.11	5.33	7.98	10.43	12.85	2.87	44.53	12.73	2.41	3.23	1.90
T_7	6.08	26.73	65.13	113.03	4.74	7.55	9.68	11.74	2.57	43.35	11.65	2.01	2.91	1.83
T_8	6.19	26.93	66.09	114.83	4.92	7.95	9.81	11.92	2.76	43.56	11.85	2.12	3.19	1.87
F- test	S	S	S	S	S	S	S	S	S	S	S	S	S	S
S. Ed. (±)	0.022	0.166	0.357	0.776	0.015	0.467	0.027	0.016	0.017	0.018	0.018	0.001	0.003	0.207
C. D. (p = 0.05)	0.045	0.343	0.737	1.602	0.031	0.964	0.056	0.034	0.035	0.037	0.036	0.002	0.005	0.428

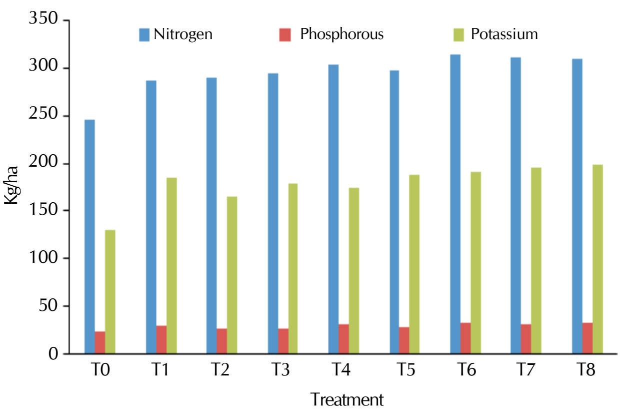

Figure 1: Effect of bio and chemical fertilizers on content of Nitrogen, phosphorous and potassium in soil after harvesting

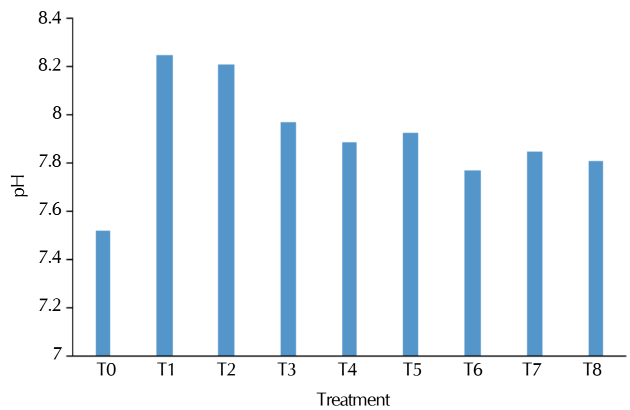

Figure 2: Effect of bio and chemical fertilizers on pH value in soil after harvesting

Similar results were show a in case of no of leaves was recorded to be maximum in T_6 The data on Number of leaves of baby corn at different growth stages as influenced by organic and inorganic fertilizers along with Biofertilizers are presented in Table 1.The Number of leaves at 15 days after sowing (DAS) differed significantly due to different treatments. Significantly higher Number of leaves (5.33) was recorded in T_6 (@ 50% RDN + *Pesudomonas putida* + *Azotobacter chroococcum* 20g kg^{-1} seed) and it was on par with the application of @ 50% RDN + *Bacillus mucilaginosus* + *Pseudomonas putida* 20g kg^{-1} seed (T_6 : 4.92) compared to control (T_0 : 2.11). Similar trend was also recorded in 30, 45 and 60 DAS.

Yield attributes

Effect of different biofertilizers treatments on yield and characters of baby corn are presented in table. It is clear from the table1.That differences between treatments were significant with regard to all the cob and baby corn characters. Maximum number of baby corn / plant was recorded in T_6 while minimum numbers of cob was found in treatment T_0. Treatments T_8, T_7, T_4 , T_5, T_3 and T_2 were found at par with respect to cob number while there was a significant difference between T_6 and T_8. However, highest cob weight [44.53g (with husk), 12.73g (without husk)] was recorded in T_6 and minimum [22.34 g (with husk), 5.91g (without husk)] in T_0.Weight of baby corn without husk was also maximum in same treatment. These results are in accordance with the work of (Shaharoona *et al.* 2006) who reported such increase in yield attributes of maize due to *Pseudomonas* inoculation and showed in table 1. Yield of baby corn/ plot (kg/plot) was the maximum in T_6 (2.41) and it was found at par with T_8 (T_8 : 2.12) While significantly minimum cob yield was recorded in T_0 (Control) (1.12) It is clear from the above result, among all the treatment combination of organic and inorganic fertilizers along with Biofertilizers was found the best T_6 (@ 50% RDN + *Pesudomonas putida* + *Azotobacter chroococcum* 20g kg^{-1} seed). Jarak *et al.* (2011) arrived at similar conclusions concerning the use of free-living and associative nitrogen-fixing bacteria in maize production. Shaukat *et al.* (2006) and Egamberdiyeva (2007) stated that biofertilizers increase maize yield by stimulating processes such as seed germination, resistance of seedlings to stress conditions, nitrogen fixation and production of phytohormone. It significantly increased the yield and yield attributes when applied with biofertilizers @ 20g kg^{-1} seed. The biofertilizers like *Azotobacter* and PSB were also found to fix atmospheric nitrogen into available nitrogen to the plants Okon *et al.* (1981). Hence the seed treatment with biofertilizers responsible for supply of nutrient to plant growth at subsequent stages of growth lead to increase in the plant growth parameters.

Biochemical parameter

The present study, the *Pseudomonas putida and Azotobacter chroococcum* had improve the total chlorophyll content values are calculated as 3.19 mg/g over the control to 2.43 mg/g in baby corn. (Table 1) Among all the treatments the maximum value of Total chlorophyll content was recorded in (T_6) (@ 50% RDN + *Pesudomonas putida* + *Azotobacter chroococcum* 20g kg^{-1} seed) (3.23), followed by (T_8) @ 50% RDN + *Bacillus mucilaginosus* + *Pseudomonas putida* 20g kg^{-1} seed (3.19) and the minimum total chlorophyll content was recorded in (T_0) (Control) (2.43). Maximum amount of chlorophyll pigment may show an efficient rate of photosynthesis. Koide reported that using Mycorrhiza increases leaf chlorophyll content and can positively affect rate of photosynthesis. The maximum N and P uptake were observed in bacteria containing treatments. This suggests that there is a direct and positive synergic effect between fungus and bacteria on soil phosphorous availability. Significantly variation on protein content was noticed due to the application of inorganic fertilizers and different Biofertilizers are presented in Table 1.Protein content was showed higher in (T_6) with the treatment @ 50% RDN + *Pesudomonas putida* + *Azotobacter chroococcum* 20g kg^{-1} seed (1.90g) and it was on par with (T_8) @ 50% RDN + *Bacillus mucilaginosus* + *Pseudomonas putida* 20g kg^{-1} seed (1.87g) and (T_6) @ 50% RDN + *Azotobacter chroococcum* + *Bacillus* 20g kg^{-1} seed (1.83 g) however lowest (1.10 g) was noticed in (T_0) Control. The above held report was in accordance with the previous result of Sudhalakshmi et al.

Soil parameter

pH

The solubilization effect is generally due to production of organic acids by these organisms. Significantly maximum pH was recorded with the treatment (2.41) was recorded in T_1 (@ RDF (N: P: K) and it was on par with the application of @ 50% RDN (T_2: 8.21). While significantly minimum pH was recorded T_6 (@ 50% RDN + *Pesudomonas putida* + *Azotobacter chroococcum* 20g kg^{-1} seed) in general, organic sources have tendency towards neutral pH soil. There is slight decrease in pH with organic sources and that attributed to the production of organic acids, viz, oxalo-acitic acid, glutamic acid (Srikanth *et al*., 2000). that means it is clear in fig. 1. And it is showed better phosphate solubilization in soil bacterium was accompanied by a considerable fall in pH. Our findings in accordance with the work of earlier researchers who confirmed the P solubilizing activity of selected strains was related to the release of organic acids and subsequent pH reduction in the soil.

N.P.K

Looking to the fertility status of soil, the different nutrient management treatments showed significant results in terms of available nitrogen, phosphorus and potash (fig. 1.) Treatment T_6 (@50% RDN + *Pesudomonas putida* + *Azotobacter chroococcum* 20g kg^{-1} seed) obtained significant improvement in soil fertility in terms of available N (314.41 kg/ha), phosphorus (32.54 kg/ha) and which were comparatively higher than rest of the treatments except the potash. Increased availability of N with the application of bio-organic could be attributed to the greater multiplication of microbes which converted organically bound N to organic form (Archina, 2008). Subramanium and Kumaraswamy (1989) reported an increase in available P content of soil. Significantly the data on available potassium of at different growth stages as influenced by organic and inorganic fertilizers along with Biofertilizers are presented in figure 1. Significantly maximum available potassium was recorded with the treatment (199.43) was recorded in T_8 (@ 50% RDN + *Bacillus mucilaginosus* + *Pseudomonas putida* 20g kg^{-1} seed) Nitrogen and phosphorous percentage in soil can be calculated by percentage of organic matter. As such, in future, gains in production levels will accrue through enhancement of productivity which will necessarily mean increased demand on soil fertility. There will be huge demand for organic sources of enriching the soils through chemical fertilizers would continue to play vital role in the enrichment of soils and subsequently the production level of crops. The data related to available of nitrogen, phosphorous and pottasium at post harvesting of crop as influenced by organic and inorganic fertilizers along with Biofertilizers are presented in Fig.1: and it was on par with the application of @ 50% RDN + *Azotobacter chroococcum* + *Bacillus mucilaginosus* 20g kg^{-1} seed) (T_7 : 195.57). While significantly minimum available potassium was recorded T_0 (Control) (130.62).

From the study it can be concluded that, the application of @ 50% RDN through inorganic fertilizers + *Pseudomonas putida* + *Azotobacter chroococcum* (20 g kg^{-1} seed) (T_6) was found better in order to obtain more biochemical, yield attributes and yield of baby corn . And high mean performance for nitrogen and phosphorous, but significantly maximum potassium was recorded in the application of T_8 @ 50% RDN + *Bacillus mucilaginosus* + *Pseudomonas putida* 20g kg^{-1} seed.

REFERENCES

Anand Swarup 2002. Lessons from long term fertilizer experiments in improving fertilizer use efficiency and crop yields. *Fertilizer News*. **47(2):** 59-66.

Archina, C. 2008. Studies on integrated nutrient management in plum (*Prunus salicina* L.) cv. Santa Rosa. Ph.D. Thesis Dr. Y S Parmar, University of Horticulture and Forestry, Nauni, Solan, India. p. 104.

Arnon, D. S. 1949. Copper enzymes in isolated chloroplast poly phenoxy oxidaes in Beta vulgaris. *Plant Physiology,* pp. 241-15.

Bray, C. M. 1983. Nitrogen Metabolism in Plants. *Longman Publishing*, London. pp. 183-202.

Egamberdiyev, A. D., 2007. The effect of plant growth promoting bacteria on growth and nutrient uptake of maize in two different soils. *App. Soil. Ecology*. **36:** 184-189.

Gomez K. A, Gomez A. A. 1984, Statistical Procedure for Agricultural Research. *J. Wiley and Sons Inc.*, New York. p. 680.

Jackson, M. L. 1973. Soil Chemical Analysis, *Prentice Hall of India Pvt. Ltd*, New Delhi. p. 498.

Jarak, M., Jelicic, Z., Kuzevski, J., Mrkovacki, N., Đuric, S. 2011. The use of azotobacter in maize production: The effect on microbiological activity of soil, early plant growth and grain \yield. *Contemporary Agriculture*. **60:** 80-85.

Koide, R. 1993. Physiology of the mycorrhizal plant. *Advance Plant Pathology*. **9:** 33-54.

Lowry, O. H., Brough, N. T. R., Farr, L. A. and Randell, R. J 1951, Protein measurement for folin phenol reagent. *J. Boil. Chem*. **193:** 265-275.

Mane, S. S., Hadgaonkar, A. K., Suryawanshi, A. P. and Salunke, S. D.

2000. Response of pearl millet to inoculation of phosphorus solubilizing bacteria and azospirillum. *J. Indian Soc. Soil Sci*. **48:** 617- 619.

Mugalkhod, A. S., Shivamurthy, D., Kumar, A. and Biradar,

M. S. 2011. Yield components of baby corn (*Zea mays* L.) as affected by planting method and irrigation schedule under drip. *Plant Achives.* **11(1):** 379-381.

Naveed, M., Khalid, M., Jones, D. L., Ahmad, R. and Zahir, Z. A. 2008. Relative efficacy of *Pseudomonas* spp., containing ACC-deaminase for improving growth and yield of maize (*Zea mays*L.) in the presence of organic fertilizer. *Pak. J. Bot*. **40(3):** 1243-1251.

Nevens, F. and Reheul, D. 2003. The application of vegetable, fruit and garden waste (VFG) compost in addition to cattle slurry in a silage maize monoculture: nitrogen availability and use. *Europ. J. Agron*. **19:** 189-203.

Okon, Y., Kapulnik, Y., Sarig, S., Nur, I., Kigel, J. and Henis, Y. 1981. Azospirillum increased cereal crop yields in field of Israel, in Current perspectives in nitrogen fixation (Eds: Ibson, A. H. and Newton, W. E.), Elsevier / North Holland Biochemical Press, Holland, pp. 461- 463.

Olsen, S. R., Cole, C. V., Watanhe, F. S. and Dean, L. A. 1954. Estimation of available Phosphorus in soils by extraction with sodium bicarbonate, *U. S. Deptt. Agr. Circ.* p. 939.

Piper, C. S. 1966. Soil and Plant Analysis. Academic Press, New York and Hans Publishers, Bombay. pp. 28-46.

Shaharoona, B., Arshad, M., Zahir, Z. A. and Khalid, A. 2006. Performance of *Pseudomonas* spp. containing ACC- deaminase for improving growth and yield of maize (*Zea mays* L.) in the presence of nitrogenous fertilizer. *Soil Biol. Biochem*. **38:** 2971-2975.

Sharifi, R. and Taghizadeh, R. 2009. Response of maize (*Zea mays* L.) cultivars to different levels of nitrogen fertilizer. *J. Food Agriculture Environment.* **7(3):** 518-521.

Shaukat, K., Affrasayab, S. and Hasnain, S. 2006. Growth responses of *Triticum aestivum* to plant growth promoting rhizobacteria used as a biofertilizer. *Res. J. Micro Biol.* **1(4):** 330-338.

Sinha, B. L., Chauhan, S. K. and Pradhan, M. K. 2011. Effect of tillage and Nitrogen on growth and yield of pearl mlillet under rainfed conditions. *Indian J. Soil Conservation.* **39(3):** 220-225.

Srikanth, K., Srinivasamurthy, C. A., Siddaramappa, R., Ramakrishnan, V. R. 2000. Direct and residual effect of enriched composts, FYM, vermicompost and fertilizers on properties of an alfisols. *J. Indian Soc. Soil Sci*. **48(3):** 496-499.

Subbiah, B. V. and Asija, G. L. 1956. A rapid procedure for estimation of available nitrogen in soils. *Curr. Sci.* **25:** 259-260.

Subramanium, K. S. and Kumaraswamy, K. 1989. Effect of continuous cropping and fertilization on chemical properties of soil. *J. Indian Soc. Soil Sci*. **37:** 171-3.

Sudhalakshmi, J., Kuberan, T., Anburaj, J., **Sundaravadivelan, C., Kumar, P. and Dhanaseeli, M. 2011.** Effect of plant growth promoting fungal inoculant on the growth of *Arachis hypogea* (L.) and it's role on the induction of systemic resistance against *Rhizoctonia solani. The Int. J. Applied Biol. and Pharmaceutical Technol.* **2:** 222-232.

Ramachandrappa, B. K., Nanjappa, H. V. and Shiva kumar, H. K. 2004. Yield and quality of baby corn (*Zea mays* L.) as influenced by spacing and fertilization levels. *Acta Agronomica Hungarica.* **52(3):** 237-243.