Performance of maize (Zea mays L.) under efficient nutrient management practices for sustainable crop productivity

Prayasi Nayak, A Pratap Kumar Reddy, N Sunitha and KV Naga Madhuri

DOI: https://doi.org/10.22271/chemi.2020.v8.11ak.8635

Abstract
A field experiment was conducted to optimise the organic, inorganic and biofertiliser needs for sustained productivity of maize (Zea mays L.). Seven treatments comprising all possible combinations of chemical fertilizer, organic manure (vermicompost, FYM) with and without biofertilizer (Azospirillum and PSB) were laid out in randomized block design with three replications. Different nutrient management practices (organic, inorganic and combined sources of nutrients) significantly influenced the yield attributes, yield and economics of maize crop. Application of 100 % RDF (T1: 180-60-50 kg N, P2O5 and K2O ha−1) resulted in significantly higher cob length, girth (17.7 cm, 16.8 cm), cob weight (225 g), no. of kernel rows cob−1 (12.9), no. of kernels row−1 (24.2), kernel weight cob−1 (5207 kg ha−1), kernel yield (5207 kg ha−1) and stover yield (6751 kg ha−1) which was significantly superior over the rest of the nutrient management practices and it was followed by 50% RDF + Vermicompost @ 1 t ha−1 + Azospirillum @ 5 kg ha−1 + PSB @ 5 kg ha−1 (T2) and it has given a remarkable yield attributes, kernel (4683 kg ha−1), stover yield (6394 kg ha−1) which is in turn in parity with 50% RDF + FYM @ 5 t ha−1 + Azospirillum @ 5 kg ha−1 + PSB @ 5 kg ha−1 (T3) and significantly superior to rest of the treatments. The highest net returns (₹ 59920 ha−1) and benefit - cost ratio (2.97) were recorded under 100% RDF (T1) followed by application of FYM @ 10 t ha−1 + Azospirillum @ 5 kg ha−1 + PSB @ 5 kg ha−1 (T6) and significantly superior to rest of the treatments. Integration of biofertilizer (T6 and T7) has triggered the nutrient uptake mechanism and shown a notable performance in improving yield structures, yield and economics. Long run adoption of combined use of fertilizers and organics expected to match and even excel the sole fertilizer based production strategy.

Keywords: Organic, inorganic, biofertiliser, yield, yield attributes, economics

Introduction
Maize an important food and feed crop of the world and often referred to as “Queen of cereals, back bone of America, miracle crop, king of grain crops”. Refineries use maize crop for producing products as corn oil, gluten for animal feed, corn starch, syrup, dextrose (used mainly by pharmaceutical industry as the starting material for manufacturing vitamin C and penicillin), alcohol for beverages, ethanol, high fructose corn syrup (used mainly by soft drinks industry), biodegradable chemicals and plastics, ready to eat snack food and breakfast cereals, corn meal, grits, flour and additives in paints and explosives. It is estimated that worldwide maize yields 4000 industrial products (Sprague et al., 1988) [12]. Maize is the third most important food crop after rice and wheat in India, mainly grown during kharif season which covers 85% of the total area. In India, it is cultivated on 9.43 million ha area, with production and productivity of 24.35 million tonnes and 2.583 kg/ha respectively (Director’s review, IIMR, 2014-15). It accounts for ~9 per cent of total food grain production in the country. India ranks 4th in maize area in the world. Maize grain is mainly used for feed (63%), food (23%) and industrial purpose (13%) in the country. To meet the rising demand, a quantum jump in maize production is the need of the hour. In the previous decade, the maize area expanded by 1.8% and production increased by 4.9% showing productivity growth at 2.6% per annum in India (Gol, 2015).
Maize (Zea mays L.) is one of the most versatile crops having wider adaptability and grown in diverse seasons and ecologies for various purposes. It is having special significance as a staple food of the tribal areas, which provides nutritional security due to its high nutritional profile. On account of its quick growth habits, maize is a highly nutrient exhaustive crop. The demand of maize plant for nitrogen and phosphorus is more than any other essential element for the development of all phases. It is absolutely necessary that essential nutrient elements should be supplied in appropriate proportion to maintain soil fertility and to get higher yield.

Now-a-days the escalating cost of chemical fertilizers is considerably resulting in lower net returns. Continuous application of fertilizers alone in a system deteriorates soil health and affects crop productivity (Kannan et al., 2013) [4]. Excessive use of agrochemicals with reduced use of organic source of nutrients for the last several decades resulted in multinutrient deficiencies and decline in fertility and productivity of soil. Although fertilizers supply quick nutrients to the soil, they impede the uptake of other nutrients and there by upset the whole mineral balance pattern. Nutrient management practice that depends less on inorganic fertilizers are required to minimize the adverse effects.

Integrated nutrient management, which includes potential sources like fertilizers, bulky organic manures and biofertilizers in a balanced proportion could help in mitigating the problems and to build an ecologically as well as economically viable farming system. Organic manures particularly FYM and vermicompost, not only supply macronutrients but also meet the requirement of micronutrients, besides improving soil health (Wailare and Kesarwani, 2017) [15]. Biofertilizers are the low cost inputs for supplementing the essential plant nutrients to achieve sustainable agriculture. The presence of different microbes, enzymes and hormones enhance the availability of soil inherent nutrients by the formation of organic acids. Hence, massive efforts are to be adopted with integration of organic, inorganic and biological sources of plant nutrients in the developing countries for improvement of soil fertility and productivity (Hashim et al., 2016) [3].

As heavy feeder of nutrients, maize productivity is largely dependent on nutrient management to express its full potential. Under the present trend of exploitative agriculture in India, inherent soil fertility can no longer be maintained on sustainable basis as the capacity of the soil to supply plant nutrient is steadily declining under intensive cropping systems. Organic manures particularly FYM and vermicompost, not only supply macronutrients but also meet the requirement of micronutrients, besides improving soil health. (Kannan et al., 2013) [4] and biofertilizers play an important role for supplementing the essential plant nutrients for sustainable agriculture (Hashim et al., 2016) [3]. Integrated nutrient management an option arises utilizing the available organic and inorganic sources to build an ecologically sound and economically viable farming system.

Material and Methods
The field experiment was conducted at S.V. Agricultural College Wetland Farm, Tirupati campus of Acharya N. G. Ranga Agricultural University in kharif, 2017. Total rainfall received during the crop growth period was 833.6 mm in 42 rainy days. The soil of the experimental field was sandy loam in texture, slightly alkaline in soil reaction (pH 7.9), low in organic carbon (0.25 %) and available N (125 kg ha$^{-1}$) and medium in available phosphorus (11.7 kg ha$^{-1}$) and available potassium (223.3 kg ha$^{-1}$).

The field experiment was laid out in Randomized Block Design (RBD). The seven treatments were replicated thrice and each consisted of a 100% recommended dose of fertiliser @ =180-60-50 kg N, P$_2$O$_5$ and K$_2$O ha$^{-1}$ (T$_1$), FYM @ 10 t ha$^{-1}$ + Azospirillum @ 5 kg ha$^{-1}$ + PSB @ 5 kg ha$^{-1}$ (T$_2$); Vermicompost @ 2 t ha$^{-1}$ + Azospirillum @ 5 kg ha$^{-1}$ + PSB @ 5 kg ha$^{-1}$ (T$_3$), 50% RDF + FYM @ 5 t ha$^{-1}$ (T$_4$), 50% RDF + Vermicompost @ 1 t ha$^{-1}$ (T$_5$), 50% RDF + FYM @ 5 t ha$^{-1}$ + Azospirillum @ 5 kg ha$^{-1}$ + PSB @ 5 kg ha$^{-1}$ (T$_6$), 50% RDF + Vermicompost @ 1 t ha$^{-1}$ + Azospirillum @ 5 kg ha$^{-1}$ + PSB @ 5 kg ha$^{-1}$ (T$_7$). The test hybrid of maize was Kaveri-55. The seed rate for maize is 20 kg ha$^{-1}$. The seeds were sown on 15th July, 2017 manually at a depth of 5 cm on the ridges which were laid at a spacing of 60 cm between the rows and 20 cm between the plants in each row.

Farm yard manure and Vermicompost were incorporated in marked plots as per treatments and its composition on dry basis was 0.51 % N, 0.25 % P$_2$O$_5$, 0.52 % K$_2$O for FYM and 1.7 % N, 1.1 % P$_2$O$_5$, 1.0 % K$_2$O. Full dose of phosphorus (60 kg ha$^{-1}$) and potassium (50 kg ha$^{-1}$) in the form of single super phosphate (SSP) and muriate of potash (MOP) were applied as basal dose at the time of sowing. Nitrogen (180 kg ha$^{-1}$) in the form of urea was applied as per the treatments in three splits viz., 1/3rd as basal, 1/3rd at knee high stage and the remaining 1/3rd at tasselling stage through band placement. For destructive sampling, five plants were sampled each time from the second border row to record dry matter production. For non-destructive sampling, representative samples of five plants were selected randomly and tagged in net plot area. The biometrical data and post-harvest observations were recorded on the tagged plants. The crop was harvested on 28 October in 2017.

Results and Discussion
Yield attributes
The differences among the nutrient management practices could not reach the level of significance with regard to number of cobs plant$^{-1}$. However, numerically maximum number of cobs plant$^{-1}$ was recorded with 100 per cent recommended dose of nutrients through fertilizers (T$_1$). The reason for having statistically similar number of cobs plant$^{-1}$ among the nutrient management practices might have been that this character was mainly genetically controlled and was less influenced by environmental factors. Similar results were perceived by Khan et al. (1999) [5].

The length and girth of the cob was significantly influenced by different nutrient management practices (Table 1). Application of 100% recommended dose of nutrients through fertilizers (T$_1$) produced the higher cob length and girth, which was significantly superior to 100 % organic and integrated treatments. It was followed by combined application of 50 % RDF + Vermicompost @ 1 t ha$^{-1}$ + Azospirillum @ 5 kg ha$^{-1}$ + PSB @ 5 kg ha$^{-1}$ (T$_7$) which was on par with T$_6$(50% RDF + FYM@ 5 t ha$^{-1}$ + Azospirillum @ 5 kg ha$^{-1}$ + PSB @ 5 kg ha$^{-1}$) and these two treatments are significantly superior to rest of the treatments. In general the treatments received combined application of organics, inorganics and biofertilizers (T$_6$, T$_7$) recorded 23 per cent extra longer cob in maize than the treatments with 100 per cent organics (T$_2$, T$_3$). The results were in close conformity with Athokpam et al. (2017). Nagaral et al. (2017) [8] and Meena et al. (2013) [7]. Application of 100% RDF directly adds nutrients to soil, needy plants ultimately accrued huge quantity of nutrients and converted to biomass and partitioned a large fraction of assimilates to the sink, resulting in
enhanced yield structure as displayed by all the yield attributes. The lower stature of cob length and girth noticed with FYM @ 10 t ha\(^{-1}\) + Azospirillum @ 5 kg ha\(^{-1}\) + PSB @ 5 kg ha\(^{-1}\) (T\(_2\)) might be due to deficiency of nutrients caused by non supply of fertilizers.

Highest cob weight recorded with treatment T\(_1\) (100 % recommended dose of nutrients through fertilizers) which was significantly superior to rest of the treatments (Table 1). Maximum cob weight recorded with 100 % RDF might be due to a rapid and a large assimilate supply to the sink. Combined application of FYM and Vermicompost each at 50 % level recorded significantly higher cob weight (15.36 per cent) than the treatments with 100 % organics (T\(_2\) and T\(_3\)). Continuous nutrient supplement through integrated nutrient management practice had favourable effect on yield attributes. Increased cob weight was due to enhanced nutrient uptake with higher concentration of macro and micronutrient. This result is in conformity with Umesha et al. (2014)\(^{[14]}\).

The maximum number of kernel rows cob\(^{-1}\), kernels row\(^{-1}\), kernel weight cob\(^{-1}\) and test weight was recorded with T\(_1\) (100 % RDF) followed by T\(_7\) (50 % RDF + Vermicompost @ 1t ha\(^{-1}\) + Azospirillum @ 5 kg ha\(^{-1}\) + PSB @ 5 kg ha\(^{-1}\) + PSB) which was found to be comparable with T\(_6\) (50% RDF + FYM @ 5 t ha\(^{-1}\) + Azospirillum @ 5 kg ha\(^{-1}\) + PSB @ 5 kg ha\(^{-1}\) and these two treatments are significantly superior to rest of the treatment (Table 1) whereas lowest performance recorded with FYM @ 10 t ha\(^{-1}\) + Azospirillum @ 5 kg ha\(^{-1}\) + PSB @ 5 kg ha\(^{-1}\) and these two treatments are significantly superior to rest of the treatment (Table 1) whereas lowest performance recorded with FYM @ 10 t ha\(^{-1}\) + Azospirillum @ 5 kg ha\(^{-1}\) + PSB @ 5 kg ha\(^{-1}\). This might be due to enhanced partitioning of photosynthesates towards newly formed sink. Moreover the increase in number of kernel rows cob\(^{-1}\) and kernels row\(^{-1}\) with the above treatment might have resulted in maximum kernel weight cob\(^{-1}\). More number of bigger sized cobs plant\(^{-1}\) might have accommodated more kernels providing sufficient space for development at balanced and adequate supply of nutrients (Ramu and Reddy, 2005). Integrating biofertilizer with vermicompost/ FYM + RDF improved the interaction between fertilizer and bacterial growth resulted in number of kernel rows per cob (14.16 per cent) over sole application of organics (T\(_3\) and T\(_2\)). Similar result was perceived by Beigzade et al., (2013)\(^{[1]}\).

**Yield**

Adequate nutrient management practices in maize either with organic and inorganic sources or their combined application significantly enhanced kernel and stover yield (Table 2). Application of 100 % nutrients through inorganic sources of fertilizer significantly improved the maize yield (T\(_1\)). The maximum kernel yield (5207 kg ha\(^{-1}\)) was obtained with T\(_1\) with the application of entire dose of recommended NPK through fertilizers and it was significantly superior to 100 % organic and integrated nutrient management practices. It was followed by T\(_7\) (50 % RDF + Vermicompost @ 1 t ha\(^{-1}\) + Azospirillum @ 5 kg ha\(^{-1}\) + PSB @ 5 kg ha\(^{-1}\) + Azospirillum @ 5 kg ha\(^{-1}\) + PSB @ 5 kg ha\(^{-1}\) + PSB) which was on par with T\(_6\) (50% RDF + FYM @ 5 t ha\(^{-1}\) + Azospirillum @ 5 kg ha\(^{-1}\) + PSB @ 5 kg ha\(^{-1}\)). Integrating Azospirillum and PSB along with FYM, Vermicompost and RDF produced remarkable yield (52.14 per cent) compared to sole application of organics. Organic manures like FYM and vermicompost also supply nutrients beneficial to crop growth and productivity. Therefore, substitution of 50 % inorganic fertilizers with Vermicompost / FYM in combination with bio fertilizer had given the kernel yield which was comparable to 100 % RDF. This is in confirmation with the findings of Shah and Wani (2017).

Integration of biofertilizer in treatment T\(_7\) (50 % RDF + vermicompost @ 1t ha\(^{-1}\) + Azospirillum @ 5 kg ha\(^{-1}\) + PSB @ 5 kg ha\(^{-1}\) + Azospirillum @ 5 kg ha\(^{-1}\) + PSB @ 5 kg ha\(^{-1}\) + PSB) recorded 19 and 23 per cent more yield compared to T\(_4\) (50 % RDF + FYM@ 5 t ha\(^{-1}\)) and T\(_3\) (50 % RDF + Vermicompost @ 1t ha\(^{-1}\)) which did not include biofertilizer. It indicates the role of biofertilizer in enhancing the easy uptake of nutrients. These results are in accordance with the findings of Beigzade et al. (2013)\(^{[1]}\) Hashim et al. (2015)\(^{[2]}\), and Rasool et al. (2015)\(^{[9]}\).

**Economics**

The economics is the main bone of contention in making the sound recommendations of any package of practices for adoption by the farmers. Gross and net returns as well as benefit-cost ratio were altered to a noticeable extent due to varied nutrient management practices in maize (Table 2 and Fig. 1). The increase in net returns might be due to increased kernel yield coupled with reduced cost of fertilizer application. The net return was recorded in the order of T\(_6\), T\(_7\), T\(_2\) and T\(_3\). The net returns indicated the fact that application of vermicompost was not much economical compared to FYM application. The negative net returns (₹ 11760 ha\(^{-1}\)) were recorded with application of Vermicompost @ 2 t ha\(^{-1}\) + Azospirillum @ 5 kg ha\(^{-1}\) + PSB @ 5 kg ha\(^{-1}\) (T\(_3\)) might be due to high cost of vermicompost (₹ 15 kg\(^{-1}\)) and lower yields as reported by Jinjala et al. (2016). The highest gross and net returns as well as benefit - cost ratio (2.97) was realized with 100 per cent recommended dose of nutrients through inorganic fertilizers (T\(_1\)). It might be due to the higher kernel and straw yields as well as lesser production costs in comparison to organic and integrated sources. These findings lend to support of Tomar et al. (2017)\(^{[13]}\).

Among the various organic and integrated nutrient management practices, application of FYM @ 10 t ha\(^{-1}\) + Azospirillum @ 5 kg ha\(^{-1}\) + PSB @ 5 kg ha\(^{-1}\) (T\(_6\)) registered a B:C ratio of 2.81 which might be due to comparatively better increase in yield with lesser cost over other treatments. This result was in accordance with the findings of Makwana et al. (2015)\(^{[6]}\).

Monetary returns play a key role, for adapting the refined agro techniques. In the present study, higher yields coupled with higher monetary returns were obtained with application of 100 % RDF but integration of different sources of nutrients through chemical, organic and biofertiliser not only improves the total crop productivity but also maintains and sustains soil health for future generation as well as improving the economic stability of the farmers.

**Conclusion**

In the present study, higher yields coupled with higher monetary returns were obtained with application of 100 % RDF but integration of different sources of nutrients either from chemical, organic and biofertilizer sources not only improves the total crop productivity but it also maintain and sustains soil health for future generation as well as improving the economic stability of the farmers. Hence, adoption of a balanced nutrient management approach will safeguard the higher crop productivity and economic returns. Long run adoption of combined use of fertilizers and organics expected to match and even excel the sole fertilizer based production strategy.
Table 1: Yield attributes of maize as influenced by various nutrient management practices

| Treatments                                      | Cob length (cm) | Cob girth (cm) | Number of kernel rows cob⁻¹ | Number of kernels row⁻¹ | Cob weight (g) | Kernel weight Cob⁻¹ (g) | Test weight (100 kernels) (g) |
|-------------------------------------------------|-----------------|----------------|-----------------------------|-------------------------|----------------|-------------------------|-------------------------------|
| T₁: 100% RDF (180 - 60 - 50 kg N, P₂O₅, and K₂O ha⁻¹) | 17.7            | 16.8           | 12.9                        | 24.4                    | 225            | 70.1                    | 24.5                          |
| T₂: FYM @ 10 t ha⁻¹ + Azospirillum@ 5 kg ha⁻¹ + PSB @ 5 kg ha⁻¹ | 11.9            | 11.5           | 10.2                        | 20.1                    | 178            | 41.9                    | 20.6                          |
| T₃: Vermicompost @ 2 t ha⁻¹ + Azospirillum@ 5 kg ha⁻¹ + PSB @ 5 kg ha⁻¹ | 12.5            | 12.1           | 10.3                        | 20.5                    | 180            | 42.4                    | 20.8                          |
| T₄: 50% RDF + FYM @ 5 t ha⁻¹ | 13.9            | 13.3           | 11                          | 21.4                    | 192            | 52.1                    | 22.3                          |
| T₅: 50% RDF + Vermicompost @ 1 t ha⁻¹ | 14.2            | 13.5           | 11                          | 21.7                    | 196            | 52.4                    | 22.6                          |
| T₆: 50% RDF + FYM@ 5 t ha⁻¹ + Azospirillum@ 5 kg ha⁻¹ + PSB @ 5 kg ha⁻¹ | 15.7            | 15.0           | 11.9                        | 22.9                    | 210            | 63.8                    | 23.7                          |
| T₇: 50% RDF + Vermicompost @ 1 t ha⁻¹ + Azospirillum@ 5 kg ha⁻¹ + PSB @ 5 kg ha⁻¹ | 16.1            | 15.2           | 12                          | 23.6                    | 213            | 65.6                    | 24.1                          |
| SEM±                                           | 0.42            | 0.33           | 0.21                        | 0.23                    | 3.3            | 0.18                    | 0.07                           |
| CD (P=0.05)                                     | 1.3             | 1.01           | 0.65                        | 0.71                    | 10.1           | 4.3                      | 0.20                           |

Table 2: Kernel yield, stover yield (kg ha⁻¹) and harvest index of maize as influenced by various nutrient management practices

| Treatments                                      | Kernel yield (kg ha⁻¹) | Stover yield (kg ha⁻¹) | Gross returns | Net returns | B : C ratio |
|-------------------------------------------------|------------------------|------------------------|---------------|-------------|-------------|
| T₁: 100% RDF (180 - 60 - 50 kg N, P₂O₅, and K₂O ha⁻¹) | 5207                   | 6751                   | 90063         | 59821       | 2.97        |
| T₂: FYM @ 10 t ha⁻¹ + Azospirillum@ 5 kg ha⁻¹ + PSB @ 5 kg ha⁻¹ | 2059                   | 4937                   | 37881         | 8547        | 1.29        |
| T₃: Vermicompost @ 2 t ha⁻¹ + Azospirillum@ 5 kg ha⁻¹ + PSB @ 5 kg ha⁻¹ | 2352                   | 4950                   | 42576         | -11760      | 0.78        |
| T₄: 50% RDF + FYM @ 5 t ha⁻¹ | 3660                   | 5790                   | 64350         | 37044       | 2.36        |
| T₅: 50% RDF + Vermicompost @ 1 t ha⁻¹ | 3949                   | 5815                   | 69004         | 29198       | 1.73        |
| T₆: 50% RDF + FYM@ 5 t ha⁻¹ + Azospirillum@ 5 kg ha⁻¹ + PSB @ 5 kg ha⁻¹ | 4534                   | 6206                   | 78742         | 50738       | 2.81        |
| T₇: 50% RDF + Vermicompost @ 1 t ha⁻¹ + Azospirillum@ 5 kg ha⁻¹ + PSB @ 5 kg ha⁻¹ | 4683                   | 6394                   | 81314         | 40810       | 2.02        |
| SEM±                                           | 88                     | 114                    | 1454          | 1454        | 0.04        |
| CD (P=0.05)                                     | 271                    | 317                    | 4479          | 4479        | 0.13        |

Fig 1: Gross returns, net returns (₹ ha⁻¹) and B:C ratio of maize as influenced by various nutrient management practices

Reference
1. Beigzade M, Maleki A, Siaddat SA, Mohammadi MM. Effect of combined application of phosphate fertilizers and phosphate solubilising bacteria on yield and yield components of maize single cross 704. International Journal of Agriculture and Crop Sciences. 2013; 6(17):1179-1185.
2. Hashim M, Dhar S, Vyas AK, Framesh V, Kumar B. Integrated nutrient management in maize (Zea mays) – wheat (Triticum aestivum) cropping system. Indian journal of Agronomy, 2015; 60(3):352-359.
3. Hashim AF, Hatim AAA, Soumya SM. Effects of chemical and bio-fertilizers on yield, yield components and grain quality of maize (Zea mays L.). African Journal of Agricultural Research. 2016; 11(45):4654-4660.
4. Kannan LR, Dhivy M, Abinaya D, Krishna RL, Krishnakumar S. Effect of Integrated Nutrient Management on Soil Fertility and Productivity in Maize. Bulletin of Environment, Pharmacology and Life Sciences. 2013; 2(8):61-67.
5. Khan MA, Khan NU, Ahmad K, Baloch MS, Sadiq M. Yield of maize hybrid-3335 as affected by N P levels. Pakistan Journal of Biological Sciences. 1999; 2:857-859.
6. Makwana ND, Thaksi JD, Der PB, Nandaniya JK. Grain yield, nutrient uptake and economics of rabi maize under different fertilizer levels and organic sources in south Gujarat condition. AGRES- An International e-Journal. 2015; 4(4):363-368.
7. Meena MD, Tiwari DD, Chaudhuri SK, Biswas DR, Narjary AL, Meena BL, Meena RB. Effect of biofertilizer
and nutrient levels on yield and nutrient uptake by maize (Zea mays L.). Annals of Agri-Bio Research. 2013; 18(2):176-181.

8. Nagaral IN, Channal B, Math KK, Manikant DS. Effect of organic and inorganic sources of nutrients on yield and yield attributes and nutrient uptake in maize. International Journal of Development Research 2017; 7(4):123334-12339.

9. Rasool S, Kanth RH, Hamid S, Raja W, Alie BA, Dar ZA. Influence of Integrated Nutrient Management on Growth and Yield of sweet corn (Zea mays L. Saccharata) under Temperate Conditions of Kashmir Valley. American Journal of Experimental Agriculture. 2015; 7(5):315-325.

10. Ramu YR, Reddy DS. Yield, nutrient uptake and economics of hybrid maize as influenced by plant stand, levels and time of nitrogen application. Crop Research. 2007; 33(1, 2 & 3):41-45.

11. Shah RA, Wani BA. Yield, nutrient uptake and soil fertility of maize (Zea mays L.) as influenced by varying nutrient management practices under temperate conditions of Kashmir valley, India. Plant Archives. 2017; 17(1):75-78.

12. Sprague GF, Fuccillo DA, Perelman LS, Stelly M. Corn and Corn Improvement 3rd Edition. American Society of Agronomy. Madison, Wisconsin, USA, 1988.

13. Tomar SS, Singh A, Dwivedi A, Sharma R, Naresh RK, Kumar V, Tyagi S, Singh A, Singh BP. Effect of integrated nutrient management for sustainable production system of maize (Zea mays L.) in Indo-Gangetic plain zone of India. International Journal of Chemical Studies. 2017; 5(2):310-316.

14. Umesh S, Srikantaih M, Prasanna KS, Sreeramulu KR, Divya M, Lakshmipathi RN. Comparative effect of Organics and Biofertilizers on Growth and Yield of Maize (Zea mays, L). Current Agriculture Research Journal. 2014; 2(1):55-61.

15. Wailare AT, Kesarwani A. Effect of integrated nutrient management on growth and yield parameters of maize (Zea mays L.) As well as soil physico-chemical properties. Biomedical Journal of Scientific and Technical Research. 2017, 2574-1241.