Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

**E-ISSN:** 2278-4136
**P-ISSN:** 2349-8234
www.phytojournal.com
JPP 2021; 10(1): 2851-2854
Received: 15-11-2020
Accepted: 29-12-2020

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# Effect of FYM, bio fertilizers and inorganic manures on growth and yield of maize under irrigated conditions

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**Abstract**
The results of the present study showed that amongst different levels of organic manure and inorganic fertilizers 30t farm yard manure (FYM) and F3 (150:100:50 kg N-$P_2$O5 and $K_2O$ /ha), respectively realized significantly higher grain yield of maize. There was no significant effect of bio-fertilizers on the grain yield alone. The treatment combination of 010F3BF1 (10t FYM with 150:100:50 kg N-$P_2O_5$ and $K_2O$/ha along with Azospirillum and PSB) gave the highest benefit, cost ratio of Rs.2.83 and net return of Rs.46,194.47/ha. In view of this it is recommended that under low and medium fertile soils, inorganic fertilizer combination of N-$P_2$O5 and $K_2O$ at the rate of 150:100:50 kg/ha, respectively along with application of 10 t FYM/ha with bio-fertilizer *Azospirillum* with PSB be used for obtaining most profitable grain yield of maize under irrigated conditions of the valley. Further, for maximization of the grain yield 30t FYM/ha instead of 10t FYM/ha may be applied.

**Keywords:** Maize, nutrition, organic manures, bio-fertilizers, azospirillum

## Introduction

Maize (*Zea mays* L.) is an important cereal crop grown all over the world and is a rich source of carbohydrates. However, among the cereals, maize has relatively higher production potential, wider adaptability and multifarious uses. But, in India, its production level is very low in comparison to other developed countries. National productivity of maize is around 1.7 tonnes / ha against the world average of about 4.2 tonnes / ha. The contribution of maize is 11.47 million tonnes from an area of 6.45 million hectares to the food grain production of our country. In India, maize is grown over an area of 6.51 million ha with a production of 11.47 million tonnes and the productivity is 1.78 t per ha. Green revolution in India witnessed phenomenal increase in fertilizer consumption and during 1995-96 it was 15.1 million tonnes NPK. We may not be in a position to spend huge sum of money towards import of fertilizers. The present hike in the price of chemical fertilizers has compelled the Indian farmers to resort to imbalanced nutrition of crops and thus reduction in crop yields. At this critical juncture there is an urgent need to optimize nutrient recycling to sustain crop production without affecting soil health and protection of environment from pollution (Lee, 1992) [1].

Maize, being an exhaustive crop depletes a major portion of plant nutrients from soil by crop harvesting. Unless the soils are supplied with nutrients removed by the crop, it will be great threat to sustain crop production. The use of chemical fertilizers is the quickest and surest way of boosting crop production, but their continuous use alone is not able to sustain the maize yield. Thus, for the sake of continued higher productivity levels of maize and for sustaining soil health, integrated plant nutrient management system (IPNMS) has become important. The basic concept of IPNMS is the promotion and maintenance of soil fertility for sustaining crop productivity through optimizing all possible resources like organic, inorganic and biological in an integrated manner, appropriate to each farming situation in its ecological, soil and economic possibilities. The principal aim of IPNMS is efficient and judicious use of all the major sources of plant nutrients in an integrated manner, so as to get maximum economic yield without any deleterious effect on Physio-chemical and biological properties of the soil. Organic manure induced improvement in soil physical, chemical and biological properties. Building up of secondary and micro-nutrients, counteracting deleterious effects of soil acidity, salinity and alkalinity and substances of soil health are the key beneficial effects associated with FYM application. Use efficiency of N fertilizers is improved in the presence of FYM. Substitution of 50% mineral fertilizer–N by FYM is different agro-ecoregions has been found to sustain the productivity in a long term experiments involving various food fodder crop sequences and organic and inorganic sources of nitrogen (Yadav, 2001).

The low input sustainable agriculture (Grubinger, 1992) [2] and reduced chemical input (Kirchner *et al*., 1993) concepts, which focus on the reconsideration of agricultural practices, such as crop residues incorporation, green manuring, FYM and bio-fertilizer use and inclusion of legumes in crop rotation will be important to maintain soil organic matter at an adequate level and to sustain reasonable productivity. Keeping these considerations in view, the present study carried out to see the interaction effects of FYM, fertilizers and bio-fertilizers on productivity of maize.

## Materials and Methods

The experiment was conducted in *Kharif* 2017 season, at the experimental farm of Department of Agriculture, SGRR (PG) College, Dehradun, Uttarakhand. The experimental site was well drained and had uniform topography. The climate is temperate-cum-sub- tropical type characterized by hot summers and severe winters. The average annual precipitation was recorded at 812 mm and the temperature ranged from 24.3 to 31.5°C, the relative humidity ranged between 64% in May to 70.8% in July and between 61.7% in June and 66% in August. Certified seed of maize variety "Kanchan" was used in the experiment. The seed was sown in lines spaced 65 cm from row to row and 25 cm from plant to plant.

The experiment was laid out in randomized block design having 3 replications. There were 18 treatment combination of 3 levels of FYM (10, 20 and 30 t/ha), 3 levels of inorganic fertilizers (90-60-30, 120-80-40 and 150-100-50 kg/ha of N-P2O5-K2O) and 2 combinations of bio-fertilizers (Azospirillum + PSB and Azotobacter + PSB). The total quantity of phosphorus and potassium as per treatment were band-placed just before sowing. One half of nitrogen was applied at sowing and rest in two splits each at knee high and tassel emergence stage as per treatment of the crop. Well decomposed FYM @ 10 t/ha, 20 t/ha and 30 t/ha was mixed in soil as per treatment before application of fertilizers. Composite soil samples from 0-15 cm depth from each replication of the experimental field were collected prior in sowing of maize. initial NPK status of the soil was 253.61, 14.83 and 198 kg/ha, respectively.

Urea, DAP and MOP were used as source of nitrogen, phosphorus and potassium, respectively, as form of chemical fertilizers. Farm Yard Manure (FYM) was used as source of nitrogen, phosphorus, potassium and micro-elements in the form of organic manure. The microbial culture of *Azotobacter*, *Azospirillum* and PSB were used as bio-fertilizers. FYM was applied at doses, to the respective plots, as per the layout plan and mixed thoroughly with the soil. Half of the nitrogen was applied as basal at the time of sowing and the remaining half of nitrogen in two splits each at knee high and tassel emergence stage in the respective plots at the rates as governed by layout plan. Phosphorus and potassium was applied, at the rates as governed by layout plan to the respective plans, at the time of sowing. *Azotobacter*, *Azospirillum* and PSB were used as a seed treatment (50 g/kg seed) to the respective plots.

Five plants were randomly selected and tagged from each plot and then average for every parameter was worked out and recorded at different growth stages i.e. knee high stage, tasseling, silking, milky and maturity stage. Plant height (cm), number of functional leaves / plant, Leaf area index, dry matter accumulation, days to reach different physiological stages, days taken to maturity post-harvest observations: cob length (cm) number of cobs per plant, number of grain rows per cob, number of grains per row, cob diameter (cm), grain yield (q/ha), stover yield (q/ha), harvest index. Soil analysis after harvest of crop was done along with the plant analysis for nitrogen, phosphorus and potassium content.

The data collected on different observations were analysed statistically using analysis of variance technique. The results are presented at 5% significance. Wherever the 'P' test was found significant at 5% probability, critical difference value was used to compare the treatment means including interaction effects. The software used for analysis was "Minitab".

## Results and Discussion

The treatment effects on various characters under study in both the years have been described and discussed in detail in preceding chapters. The important findings are summarized here under:

### Effect of organic manure (FYM)

Application of FYM in maize significantly increased the plant height, number of functional levels per plant and leaf area index at all crop growth stages up to 30 t FYM/ha during the year 2017, except at knee high stage where the effect of FYM application was found non-significant. Dry matter production significantly and consistently increased with FYM application up to 30 t/ha, through it remained at par with 20 t FYM/ha at silking stage during the year. Also 20 t FYM/ha remained at par with 10t FYM/ha during the year at milky and at harvest stage. Days to reach various physiological stages were significantly and consistently enhanced with the increase in FYM application up to 30 t/ha. Cob length, number of cobs/plant, number of grain rows per cob, number of grains per row and 1000-grain weight increased significantly and consistently with the application of FYM at 30 t/ha over 20 t FYM/ha and 10 t FYM/ha. However, cob diameter increased only up to 20 t FYM/ha. The beneficial effect of FYM may be attributed to the fact that it supplied available plant nutrients and also had solubilizing effect on fixed forms of nutrients in soil (Ganai and Singh, 1988) [4]. Similar results were also obtained by Srinivasan (1992) [6], Rameshwar and Singh (1998b) [4]. Increase in plant height with the application of FYM at a rate of 30 t/ha has also been reported by Freitas and Stamford (2002) [5]. Grain and stover yield showed significant improvement with FYM application index did not show any marked improvement as a result of increase in the rates of FYM application during the year of investigation. Both nitrogen content and uptake at various crop growth stages as well as in grain and stover showed marked improvement with FYM application at 30 t FYM/ha over 20 and 10 t FYM/ha. Phosphorus content and uptake at various crop growth stages showed marked improvement with each increase in FYM application up to 30 t/ha. However, grain and stover increased significantly only up to 20t FYM/ha. Farm Yard Manure (FYM) at 30 t/ha significantly increased potassium content and uptake of maize at all crop growth stages. However, potassium uptake by grain significantly increased up to 20t FYM/ha. These findings are in conformity with those of Brar *et al*., (2001) [8] and Jayaprakash *et al.* (2003) [7]. Increase in stover yield with the increase in FYM application has also been reported by Singh *et al.*, (1995) [4], Singh *et al.*, (1999) [4] and Ailincal *et al.* (1994) [9]. Increase in stover yield with increase in rates of FYM could be attributed to significant improvement in plant height and dry matter accumulation of maize. However, harvest index did not influence much by organic manure (FYM) application.

**Effect of inorganic fertilizers**

Plant height, number of functional leaves per plant and leaf area index were positively influenced by application of inorganic fertilizers. Dry matter production increased significantly and consistently at all crop growth stages with increase in fertility levels from F1 to F3 baring at silking stage. Days taken to various physiological stages increased by increasing of fertility levels from F1 to F3. Yield attributing characters such as cob length, no. of cobs per plant, no. of grain rows per cob, no. of grains per row and 1000-seed weight showed significant improvement with increasing fertility levels from F1 to F3. Both grain and stover yield showed significant and consistent improvement with inorganic fertilizer application up to F3 fertility level. Harvest index did not show any significant increase as a result of increase in the rates of fertility levels.

Both nitrogen content and uptake at various growth stages as well as in grain and stover showed marked improvement with increase in fertility levels. Phosphorus content and its uptake in plant, grain and stover increased significantly by increasing fertility levels. However, at silking stage, both phosphorus content and uptake increased significantly only up to F2. Potassium content and its uptake in plant, grain and stover increased significantly by increasing fertility levels. Grain nitrogen content was more than stover which might have been due to translocation of nitrogen from vegetative parts towards generative parts of plant leaving stover poor in nitrogen (Hatwar *et al.*, 1992) [10]. In general, total uptake of a nutrient by plant depends along with other factors on dry matter production and nutrient concentration as the uptake is mathematically equal to the product of dry mater production and its respective nutrient concentration. Studies on nutrient concentration in maize plant at various growth stages revealed that maximum values of phosphorus content of plant tissue were found at 30 DAS stage which declined with advancement in growth. The study showed that increase in the rates of FYM up to 30 t/ha significantly increased the phosphorus uptake due to FYM could be attributed to synergistic effect of nitrogen in FYM with phosphorus. When water soluble phosphorus compounds and nitrogen are applied together, plant roots proliferate extensively in that area of treat soil resulting in more uptake of the nutrient. Similar results were also reported by Kumari and Singaram (1996), Vadevel *et al.* (2000) and Brar *et al.* (2001) [8].

**Effect of bio-fertilizer**

Application of different combination of bio-fertilizers did not create any significant improvement in the plant height, number of functional levels, leaf area index and dry matter production at any crop growth stage. Days to reach various physiological stages were not much affected by application of bio-fertilizers. Yield attributing characters did not show any significant improvement with different combinations of bio-fertilizers. Both grain and stover yield and harvest index did not show any marked improvement as a result of application of different bio-fertilizers. Nitrogen, phosphorous and postassium content and its uptake at various crop growth stages as well as grain and stover did not create any significant improvement by application of bio-fertilizer.

**Table 1:** Effect of FYM, inorganic fertilizers and bio-fertilizers on growth and nutrient uptake in maize

| Treatments | Plant height cm (At harvest) | LAI (At harvest) | Uptake of N (Grain in kg/hac) | Uptake of P (Grain in kg/hac) | Uptake of K (Grain in kg/hac) |
|---|---|---|---|---|---|
| **Farm yard manure** | | | | | |
| O10 (10t FYM/ha) | 178.09 | 2.20 | 65.22 | 17.32 | 17.06 |
| O20 (20t FYM/ha) | 184.10 | 2.35 | 75.85 | 20.14 | 24.53 |
| O30 (30t FYM/ha) | 190.08 | 2.45 | 84.18 | 22.43 | 28.93 |
| S.Em+ | 1.13 | 0.004 | 1.82 | 0.83 | 1.59 |
| CD (*p*=0.05) | 3.27 | 0.011 | 5.23 | 2.39 | 4.56 |
| **Inorganic fertilizers (Kg/ha)** | | | | | |
| F1 (90:60:30) | 179.31 | 2.14 | 60.81 | 15.57 | 14.11 |
| F2 (120:80:40) | 185.27 | 2.32 | 75.80 | 20.23 | 23.06 |
| F3 (150:100:50) | 195.59 | 2.53 | 88.64 | 24.09 | 36.06 |
| S.Em+ | 1.13 | 0.004 | 1.82 | 0.83 | 1.59 |
| CD (*p*=0.05) | 3.27 | 0.011 | 5.23 | 2.39 | 4.56 |
| **Bio-fertilizers (kg/ha)** | | | | | |
| BFI (Azospirillum + PSB) | 185.34 | 2.33 | 73.54 | 20.35 | 23.70 |
| BF2 (Azotobactor + PSB) | 184.78 | 2.33 | 76.63 | 19.58 | 22.95 |
| S.Em+ | 0.74 | 0.002 | 1.20 | 0.55 | 1.05 |
| CD (*p*=0.05) | NS | NS | NS | NS | NS |

**Table 2:** Effect of FYM, inorganic fertilizers and bio-fertilizers on yield and nutrient uptake in maize

| Treatments | No. of cobs per plant | No. of grains rows per cob | Cob length |
|---|---|---|---|
| **Farm yard manure** | | | |
| O10 (10t FYM/ha) | 1.15 | 14.00 | 16.60 |
| O20 (20t FYM/ha) | 1.19 | 16.00 | 18.16 |
| O30 (30t FYM/ha) | 1.22 | 16.80 | 19.17 |
| S.Em+ | 0.002 | 0.25 | 0.08 |
| CD (*p*=0.05) | 0.08 | 0.75 | 0.23 |
| **Inorganic fertilizers (Kg/ha)** | | | |
| F1 (90:60:30) | 1.13 | 12.60 | 15.90 |
| F2 (120:80:40) | 1.19 | 16.00 | 18.14 |
| F3 (150:100:50) | 1.25 | 18.40 | 19.90 |
| S.Em+ | 0.002 | 0.25 | 0.08 |
| CD (*p*=0.05) | 0.008 | 0.75 | 0.23 |

| Bio-fertilizers (kg/ha) | | | |
|---|---|---|---|
| BFI (Azospirillum + PSB) | 1.19 | 16.00 | 17.88 |
| BF2 (Azotobactor + PSB) | 1.19 | 16.40 | 18.08 |
| S.Em+ | 0.001 | 0.17 | 0.05 |

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