International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(5): 2020-2022

Received: 11-07-2018
Accepted: 15-08-2018

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# Plant nutrient content and uptake as influenced by plant densities and nutrient management approaches of QPM hybrids

**Bahadur Singh, SL Mundra, Dilip Singh, MK Kaushik and SL Jat**

**Abstract**
A field experiment was conducted at Udaipur (Rajasthan) during *kharif* season of 2014 and 2015 to study the effect of nutrient management approaches on the performance of quality protein maize (*Zea mays* L.) hybrids at varying plant densities. It is based on the principle of select most suitable nutrient management approach for maize plant densities. The results of experiment revealed that N and P content, uptake and total uptake by crop was significantly higher with STCR approach which was significantly superior to rest of the treatments and remained at par with SSNM. Higher N and P content were obtained in normal density compared to high density. However, N and P uptake by the crop was recorded the highest in high density.

**Keywords:** content, uptake, total uptake, plant densities, nutrient management approaches

## Introduction
Maize (*Zea mays* L.) is an important cereal crop of the world serving as food for man and forage for cattle. It is called as "Queen of cereals" and "King of fodder" due to its great importance in human and animal diets. Globally, it is grown on approximately 140 m ha area under diverse climatic conditions. In India, it is grown on 8.69 million hectares with the production and productivity of 21.81 million tones and 25.09 q $ha^{-1}$, respectively (Agricultural Statistics at a Glance, 2016). In Rajasthan this crop occupies 0.87 million hectares area with production of 1.60 million tones and productivity of 17.92 q $ha^{-1}$ (Commissionerate of Agriculture, Rajasthan, 2017-18) [2]. It is a one of the most versatile emerging crops having wider adaptability and is grown in diverse seasons and ecologies for various purposes.
As a fodder and grain crops, it is extensively grown in Uttar Pradesh, Rajasthan, Madhya Pradesh, Bihar and Karnataka. The productivity of any crop is the ultimate result of its growth and development. Plant population is the prime factor for getting maximum yield. Plant population is decided by the inter and intra row spacing of crops (Srikanth *et al.,* 2009) [9]. Optimum plant population for any crop varies considerably due to environment under which it is grown. Maize is wide spaced crop having slow growth rate in its early stage which leads to more loss of water and nutrient through evaporation and weed. To overcome this problem adoption of appropriate plant density is gaining importance in maize productivity areas of India. But, production is limited by low fertilizer-use efficiency and inadequacy in existing fertilizer recommendations. There exists significant opportunity to increase fertilizer use efficiency and productivity of a crop by adopting nutrient management approaches.

## Materials and Method
The present investigation was carried out at Instructional Farm, Rajasthan College of Agriculture, Udaipur, Rajasthan. The geographical location of the site is located at latitude of $23^0$. 34'N and longitude of $73^0$.42' E, altitude of 582.17 m above the mean sea level. The soil of the experimental field was clay loam having mean value of pH 8.3, organic carbon 0.65%, available N 270 kg $ha^{-1}$, phosphorus 19.1 kg $ha^{-1}$ and available potassium 299.5 kg $ha^{-1}$. The treatment consisting of two QPM hybrids (HQPM-1 & Pratap QPM hybrid-1) and two plant densities {normal (60 cm x 20 cm) & high density (50 cm x 20 cm)} in main plots and four nutrient management approaches (RDF, SSNM, STCR & Green seeker approach) in sub plots. All the treatments were replicated four times in split plot design. The crop was sowned on 9th July 2014 and 29th June 2015.

Atrazine 0.50 kg ha$^{-1}$ was sprayed as pre - emergence for weed control. The fertilizer nitrogen as per treatment in all the approaches except Green seeker approach was applied in four splits *viz.*, 25% at sowing, 25% at 6-8 leaf stage, 25% at knee high stage and remaining 25% at 50 per cent tasseling. In case of Green seeker approach 50% N of the recommended dose was applied at sowing and remaining was applied on the basis of green seeker reading at knee high and 50% tasseling. The nutrient content, uptake and total uptake was observed from five plants sampled randomly from each plot at 50 DAS and at harvest of crop.

## Results and Discussion

### Nutrient content

### Nitrogen

Plant density had significant influence on the N content in plants (Table 1). Normal density recorded higher N content in plants at 50 DAS, in grain and stover at harvest. This might be due to lower plant population which led to higher dry matter production of individual plants. Reddy and Khera (2000) [7] and Srikanth *et al.* (2009) [9] have also reported that wider spacing was advantageous as compared to narrow spacing for more nutrient content.

The maximum N content of plant at 50 DAS was registered with STCR approach during either of the years as well as application of nutrient on STCR based approach recorded higher N content at 50 DAS which was significantly superior to all other approaches in either of the years. Further data showed that N content in grain was recorded the highest in STCR approach, which being at par with SSNM approach was found significantly superior to both RDF and Green seeker approaches. Surprisingly, STCR approach brought about a significant increase in N content of stover over Green seeker but at par with RDF and SSNM approach during both the years of investigation (Table 1).

**Table 1:** Effect of treatments on N content (%) in plants at 50 DAS, grain and stover of quality protein maize

| Treatments | N content (%) | | | | | | P content (%) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | At 50 DAS | | Grain | | Stover | | At 50 DAS | | Grain | | Stover | |
| | 2014 | 2015 | 2014 | 2015 | 2014 | 2015 | 2014 | 2015 | 2014 | 2015 | 2014 | 2015 |
| **QPM hybrids** | | | | | | | | | | | | |
| Pratap QPM hybrid-1 | 2.114 | 2.121 | 1.603 | 1.762 | 0.733 | 0.747 | 0.531 | 0.534 | 0.4352 | 0.4382 | 0.1364 | 0.1389 |
| HQPM-1 | 2.218 | 2.225 | 1.681 | 1.849 | 0.798 | 0.813 | 0.554 | 0.557 | 0.4545 | 0.4576 | 0.1523 | 0.1562 |
| S Em ± | 0.013 | 0.013 | 0.008 | 0.010 | 0.004 | 0.004 | 0.003 | 0.003 | 0.0026 | 0.0026 | 0.0011 | 0.0009 |
| C D (P=0.05) | 0.042 | 0.041 | 0.027 | 0.031 | 0.014 | 0.014 | 0.010 | 0.010 | 0.0084 | 0.0084 | 0.0035 | 0.0028 |
| **Plant densities** | | | | | | | | | | | | |
| Normal | 2.236 | 2.243 | 1.695 | 1.864 | 0.796 | 0.810 | 0.560 | 0.563 | 0.4593 | 0.4625 | 0.1475 | 0.1508 |
| High | 2.096 | 2.103 | 1.589 | 1.748 | 0.735 | 0.749 | 0.525 | 0.528 | 0.4304 | 0.4333 | 0.1413 | 0.1444 |
| S Em ± | 0.013 | 0.013 | 0.008 | 0.010 | 0.004 | 0.004 | 0.003 | 0.003 | 0.0026 | 0.0026 | 0.0011 | 0.0009 |
| C D (P=0.05) | 0.042 | 0.041 | 0.027 | 0.031 | 0.014 | 0.014 | 0.010 | 0.010 | 0.0084 | 0.0084 | 0.0035 | 0.0028 |
| **Nutrient management approaches** | | | | | | | | | | | | |
| RDF | 2.137 | 2.144 | 1.620 | 1.781 | 0.764 | 0.778 | 0.531 | 0.535 | 0.4358 | 0.4388 | 0.1415 | 0.1446 |
| SSNM | 2.193 | 2.201 | 1.663 | 1.829 | 0.767 | 0.781 | 0.564 | 0.568 | 0.4630 | 0.4661 | 0.1570 | 0.1604 |
| STCR | 2.227 | 2.234 | 1.688 | 1.856 | 0.777 | 0.791 | 0.570 | 0.574 | 0.4682 | 0.4713 | 0.1601 | 0.1636 |
| Green Seeker | 2.106 | 2.114 | 1.597 | 1.756 | 0.755 | 0.769 | 0.503 | 0.506 | 0.4125 | 0.4153 | 0.1190 | 0.1216 |
| S Em ± | 0.015 | 0.015 | 0.011 | 0.013 | 0.005 | 0.005 | 0.004 | 0.004 | 0.0030 | 0.0031 | 0.0015 | 0.0011 |
| C D (P=0.05) | 0.043 | 0.044 | 0.033 | 0.039 | 0.015 | 0.015 | 0.010 | 0.011 | 0.0085 | 0.0088 | 0.0042 | 0.0031 |

### Phosphorus

During both the years of study, decrease in plant density from 1,00,000 to 83,333 plants ha$^{-1}$ significantly enhanced P content. Data in Table 1 showed that the highest P content in plants at 50 DAS, grain and stover at harvest was statistically superior over RDF, SSNM and Green seeker approaches. Maintenance of 1,00,000 plants ha$^{-1}$ decreased P content in these observation which could be probably due to availability of lesser space to each plant for root proliferation and development of root activity. Similar finding was also reported by Srikanth *et al.* (2009) [9].

P content was significantly influenced by nutrient management approaches (Table 1). Maximum P content was recorded under STCR approach which significantly increased P content in plant at 50 DAS and in grain over RDF and Green seeker but at par with SSNM approach during 2014 and 2015. However, the highest P content of stover at harvest was estimated in STCR approach which was significantly higher over SSNM, RDF and Green seeker during both the years. This may be due to increased concentration of phosphorus in soil solution. Phosphorus application enhances the soil microbial activity which is helpful in solubilising native phosphorus and increase content of phosphorus by maize crop (Kumar *et al.*, 2014, and Sharma, 2017) [4, 8].

### Nutrient uptake and total uptake

### Nitrogen

Plant densities presented in Table 2 reveal a significant effect on N uptake and total uptake by crop during both the years of investigation. Data show that the highest N uptake and total uptake by plants at 50 DAS and uptake in stover at harvest was recorded under 1,00,000 plants ha$^{-1}$ which was found significantly superior to 83,333 plants ha$^{-1}$. In grain, increase plant density from 83,333 to 1,00,000 plants ha$^{-1}$ had no significant bearing on the N uptake. This might be due the quantum of N removal per unit area was found to be inversely related to plant density and nutrient absorption by individual plants. Similar finding was also reported by Nanjundappa and Manure (2002) [5].

It is obvious from the data presented in Table 2 that application of STCR approach increased nitrogen uptake and total uptake by plant at all stages as compared to SSNM, RDF and Green seeker. This may be attributed to better crop growth and higher uptake of nutrient in the STCR approach which might have improved nitrogen use efficiency with more appropriate nitrogen rates in the STCR approach. These results are in accordance with Sharma (2017) [8].

**Table 2:** Effect of treatments on Nutrient uptake and total uptake by crops.

| Treatments | N uptake (kg ha$^{-1}$) | | | | | | | | P uptake (kg ha$^{-1}$) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | At 50 DAS | | Grain | | Stover | | Total uptake | | At 50 DAS | | By Grain | | By Stover | | Total uptake | |
| | 2014 | 2015 | 2014 | 2015 | 2014 | 2015 | 2014 | 2015 | 2014 | 2015 | 2014 | 2015 | 2014 | 2015 | 2014 | 2015 |
| **QPM hybrids** | | | | | | | | | | | | | | | | |
| PQPM hy-1 | 80.00 | 83.01 | 65.14 | 75.77 | 45.26 | 47.64 | 110.39 | 123.41 | 20.07 | 20.90 | 17.75 | 18.90 | 8.61 | 9.07 | 26.36 | 27.97 |
| HQPM-1 | 106.08 | 111.49 | 75.85 | 87.17 | 54.71 | 57.70 | 130.56 | 144.87 | 26.52 | 27.97 | 20.55 | 21.62 | 10.44 | 11.08 | 30.99 | 32.70 |
| S Em. ± | 1.20 | 1.44 | 1.38 | 1.71 | 0.96 | 0.90 | 1.29 | 1.63 | 0.33 | 0.38 | 0.44 | 0.47 | 0.19 | 0.23 | 0.53 | 0.46 |
| CD (P=0.05) | 3.85 | 4.61 | 4.43 | 5.46 | 3.07 | 2.87 | 4.12 | 5.21 | 1.05 | 1.21 | 1.39 | 1.51 | 0.62 | 0.72 | 1.70 | 1.46 |
| **Plant densities** | | | | | | | | | | | | | | | | |
| Normal | 89.92 | 93.85 | 69.09 | 80.70 | 46.20 | 48.68 | 118.10 | 130.91 | 22.48 | 23.56 | 18.77 | 20.07 | 8.88 | 9.39 | 28.41 | 29.83 |
| High | 96.16 | 100.65 | 71.90 | 82.23 | 53.76 | 56.67 | 122.85 | 137.37 | 24.11 | 25.32 | 19.53 | 20.44 | 10.17 | 10.76 | 28.94 | 30.84 |
| S Em ± | 1.20 | 1.44 | 1.38 | 1.71 | 0.96 | 0.90 | 1.29 | 1.63 | 0.33 | 0.38 | 0.44 | 0.47 | 0.19 | 0.23 | 0.53 | 0.46 |
| CD (P=0.05) | 3.85 | 4.61 | NS | NS | 3.07 | 2.87 | 4.12 | 5.21 | 1.05 | 1.21 | NS | NS | 0.62 | 0.72 | NS | NS |
| **Nutrient management approaches** | | | | | | | | | | | | | | | | |
| RDF | 90.21 | 94.21 | 64.03 | 74.49 | 45.95 | 48.62 | 109.98 | 123.11 | 22.44 | 23.54 | 17.23 | 18.36 | 8.51 | 9.04 | 25.74 | 27.40 |
| SSNM | 96.11 | 99.70 | 74.15 | 85.35 | 52.01 | 54.66 | 126.16 | 140.01 | 24.70 | 25.73 | 20.66 | 21.75 | 10.63 | 11.22 | 31.29 | 32.97 |
| STCR | 102.47 | 107.20 | 83.47 | 96.58 | 58.60 | 61.91 | 142.07 | 158.48 | 26.18 | 27.47 | 23.13 | 24.50 | 12.05 | 12.78 | 35.18 | 37.28 |
| Green Seeker | 83.35 | 87.89 | 60.33 | 69.45 | 43.36 | 45.50 | 103.70 | 114.96 | 19.87 | 21.01 | 15.59 | 16.43 | 6.90 | 7.27 | 22.49 | 23.70 |
| S Em ± | 1.89 | 1.46 | 1.27 | 1.46 | 0.65 | 1.07 | 1.15 | 1.75 | 0.41 | 0.42 | 0.36 | 0.36 | 0.16 | 0.24 | 0.41 | 0.44 |
| CD (P=0.05) | 5.42 | 4.18 | 3.64 | 4.20 | 1.85 | 3.07 | 3.31 | 5.03 | 1.16 | 1.20 | 1.02 | 1.03 | 0.46 | 0.70 | 1.19 | 1.25 |

**Phosphors**

During 2014 and 2015, increase in plant density from 83,333 to 1, 00,000 ha$^{-1}$ significantly increased P uptake by plant at 50 DAS and uptake by stover at harvest. Data show in Table 2 that the highest P uptake recorded in high density which was significantly higher over normal density. However, plant density had no significant effect on P uptake by grain and total uptake by crop during investigation period. This might be due to higher biomass yield under high density over lower density. The results are in close accordance with findings of Dua *et al*. (2013) [3] and Sharma (2017) [8].

The data in Table 2 reveal that STCR approach significantly increased P uptake and total uptake by plants at 50 DAS, uptake by grain and stover at harvest of QPM hybrids over rest of nutrient management approaches during both the years of investigation. This might be due to increased growth and dry matter production with the application of N and also due to increased N uptake. These results are in confirmation with Parthipan (2000) [6] and Sri kanth *et al*. (2009) [9].

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