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Precision nutrient management in maize (*Zea mays*) for higher productivity and profitability

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Maize (*Zea mays* L.) is the third most important crop after rice and wheat in India. The area, production and productivity of maize crop were 9.9 Mha, 28.72 MT and productivity 3.02 t/ha respectively during 2017–18 (Annonymous 18). It provides approximately 30% of the food calories to 4.5 billion people including 94 developing countries (Jat *et al.* 2013). The demand for maize grain is increasing due to rapid growth in poultry and animal husbandry feed sector. The huge yield gap exists due to mismatch between state recommendation and farmers practice which is not only decreases the yield but also causes nutrient mining in regions like Indo-Gangetic plains (IGP). The increased productivity up to 7 t/ha due to introduction of single cross hybrids in maize resulted in removal of nutrient to 420 kg/ha (Jat *et al.* 2013). Due to heavy nutrient requirement by maize crop, over and under nutrient fertilization results in lesser yield than the genetic yield potential and decreased profits, this leads to finally deterioration soil health. To address this complex problem of nutrient mining and deterioration of soil health, Site Specific Nutrient Management (SSNM) is one of the way of increasing the crops productivity and sustains the soil health through ensuring adequate supply of the nutrients specific to the crop and soil (Singh *et al.* 2016). Nutrient Expert aims to account for soil indigenous nutrient supply including from manures and crop residues and for applied chemical fertilizers at optimal and critical stages helping in correcting the nutrient requirement of high demanding cereal crop and increases the yield. Likewise, Green seeker is an efficient RTN tools and their calibration for specific crop and agro climatic conditions will help in increasing nitrogen use efficiency and reduces the wastage of N to great extent. Testing nutrient responses, evaluation and calibration of Nutrient Expert® in maize crop under semi-arid conditions would help in its further refinement of Nutrient Expert® and its robust utility. Therefore, with this background a research work on Precision nutrient management in maize through nutrient expert and decision support tools will be undertaken.

The experiment was conducted during *kharif* 2018 at the Experimental Farm of ICAR–Indian Agricultural Research Institute (IARI), New Delhi, India. The soil of the experimental field was of sandy loam texture with neutral to alkaline in chemical reaction. Walkley–Black C (oxidizable–SOC) 0.328%, alkaline KMnO4 oxidizable–N 241.08 kg/ha, 0.5 M $NaHCO_3$ extractable–P 10.54 kg/ha and 1 N NH4OAc extractable–K 256.38 kg/ha. Hence the soil low in organic carbon, available N and available P and medium in available K. The general climatic conditions of the experimental sites are semiarid with hot summer and severe winter. The annual rainfall during the research period of 2018 (July-October) was 992.0 mm with total evaporation of 567.3 mm. The mean daily evaporation reached as high as 5.0-5.8 mm in July and end of October 2019, however comparatively lower pan evaporation was recorded during September and some days during October which reached to 2.0 mm. The experiment laid out in Randomized Complete Block Design. The experiment was consisting of nine treatments of different nutrient management. Treatment 1 (T_1) consists of state recommendation with 150-80-60 kg/ha. Treatments 2&3 (T_2 and T_3) consists of Nutrient Expert recommendation for 6t/ha and 7t/ha respectively. Treatments 4&5 (T_4 and T_5) include Nutrient Expert recommendation with Green seeker reading for second split for 6 t/ha and 7 t/ha respectively. State recommendation with green seeker for second split comprised treatment 6 (T_6). Treatments 7, 8 and 9 followed the same recommendations of the treatment 1, 2 and 3 respectively except there is no nitrogen application. The nutrients were applied according to the treatments.

Effect on growth and yield attributes: The precision nutrient management significantly influenced the plant. It

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Table1 Growth and yield attributes of maize as influenced by different precision nutrient management techniques

Treatment	Plant height, cm	Dry weight, gm/plant	Leaf area 60 DAS	Cob length	Cob girth	Cob weight/ cob	Grain weight	No, of cobs/m^2	1000 seed weight, g	No of grains/ cob
SR	184.1	235.5	5866	14.41	13.84	36.3	26.5	52.33	276.6	320.3
NE6T	188.9	254.2	4978	15.22	14.18	38.4	28.3	55.33	283.6	362.5
NE7T	192.5	276.1	5781	15.92	14.67	39.7	29.9	60.67	299.6	393.4
NE+GS6T	185.5	250.3	4872	14.89	14.10	36.9	26.9	53.67	277.7	336.0
NE+GS7T	191.3	267.1	5722	15.69	14.41	38.6	28.8	56.67	287.9	364.2
SR+GS	179.5	205.7	5195	14.30	13.76	34.8	25.2	52.67	272.2	311.1
SR-N	140.1	98.6	2268	8.97	12.01	12.6	9.2	33.33	193.9	186.8
NE6T-N	148.2	101.1	2349	9.33	12.27	14.1	10.2	34.67	200.5	189.4
NE7T-N	150.9	106.3	2562	9.84	12.37	14.9	10.7	36.67	204.8	197.9
SEM	2.75	5.2	290	0.20	0.21	0.7	0.5	1.32	5.2	6.4
CD 5%	8.23	15.6	870	0.59	0.62	2.2	1.5	3.96	15.5	19.1

is also evident that maximum increase in plant height was between 30 and 60 DAS (Table 1). This was due to typical sigmoid growth curve and in later stages there was no effect on plant growth including plant height (Shukla *et al*. 2004). N omission reduces greenness, lesser chlorophyll formation, consequently decreased plant growth. However, NE+GS7T, NE6T, NE7T, and NE+GS 6T recorded statistically at par plant height of maize crop due to similar availability of plant nutrients. Majumdar *et al*. (2014) found that SSNM for maize increased plant height including other growth parameters of maize. Dry matter accumulation of maize was influenced by PNM options (Table 1). At 90 DAS, dry matter accumulation was increased substantially at 90 DAS over 60 DAS and 30 DAS and significantly higher dry matter accumulation was recorded in NE7T (194.76 g/plant). Nitrogen omission with state recommendation, NE6T-N and NE7T-N SSNM for maize significantly increased plant dry matter accumulation, maize compared to unfertilized plots due to better plant nutrition to maize crop under NE and GS based nutrient application. In PNM, basic approach is feeding the crops rather than feeding the soil by synchronizing nutrient supply with plant needs. Assessing plant nutrient demand from plants is more efficient strategy as plant growth at any given time integrates the effect of nutrient supply from all the sources and is thus a reliable indicator of its availability. These may the reasons for higher crop growth rate in maize crop under precision nutrient management (Singh *et al*. 2016)

Effects on yield attributes of maize: Enhanced yield attributes under PNM resulted in enhanced seed yield. There was higher nutrient uptake, and partitioning of the NPK and other nutrients and which accelerated the growth and yield attributes. This is the main reason for yield enhancement of maize under PNM. Maximum cob length (15.92 cm) was under NE7T. Similar was the trend with cob girth (12.01-14.67). The number of grains per row ranged 18.7-33.5 and varied significantly under various treatments. Maximum number of grains per row was recorded under NE7T (Table 1). The highest cob weight was recorded under NE7T (39.7 g). NE7T also resulted in maximum 1000

Table 2 Seed, biological yield, straw yield, shelling percentage and harvest index of maize under different precision nutrient management options

Treatment	Grain yield (kg/ha)	Total biomass (kg/ha)	Harvest index	Net return (₹/ha)	Added return on treatments (₹/ha)	B:C ratio
SR	5415.2	15646.5	34.6	59916	0	2.86
NE6T	5741.3	16128.1	35.6	67643	7726	3.26
NE7T	6217.7	16721.6	37.2	75194	15278	3.47
NE+GS6T	5538.3	15887.7	34.8	64486	4570	3.17
NE+GS7T	5960.9	16146.7	36.9	71284	11368	3.37
SR+GS	5152.9	14836.6	34.7	55616	-4300	2.74
SR-N	2525.3	9477.6	26.6	12992	-46925	1.43
NE6T-N	2621.8	9330.8	28.2	16848	-43068	1.61
NE7T-N	2849.3	9762.7	29.2	20451	-39465	1.73
SEM	159.9	469.3	0.3	2718		0.09
CD 5%	479.4	1406.9	1.0	8150		0.28

seed weight (299.6 g) (Table 1). Banerjee *et al.* (2014) and Singh *et al*. (2016) also reported enhanced yield attributes under NE and green seeker based nutrient management. The need-based variable-rate fertiliser-nutrient application approach has a great potential in increasing crop growth, yield attributes and ultimately higher seed yield and also revamped fertiliser/nutrient use efficiency by overcoming the problem of over- and under fertilization (Schirrmann and Domsch 2011).

Effects of different nutrient management practices on seed yield and economics: Grain yield of maize was highest under NE7T nutrient management (6.2 t/ha). This was due to higher growth and yield attributes under NE7T precision nutrient management (PNM). The increase in yield in SSNM was due to better translocation of photosynthates from source to sink, improved growth parameters and due to higher application of inorganic fertilizers (Neha *et al*. 2017). The harvest index of maize was also maximum harvest index was recorded under NE7T (37.2) (Table 2). Due to need based fertilizer management for a target yield in NE based treatment; cob yield, grain and stover yield were found superior (Singh *et al*. 2018).The net return which is a more effective parameter for economic evaluation showed that it ranged between ₹ 12992 to 75194/ha. The precision nutrient management options clearly impacted the net return and the maximum net return was estimated under NE7T (₹ 75194) (Table 2). Similarly, NE+GS 7T was also significantly higher over SR. Benefit-cost ratio also varied significantly under different nutrient management options (Table 2). The highest B:C ratio was in NE7T, which was significantly higher over SR, SR+GS and all N omission nutrient management. SSNM therefore helps in managing this risk by tactical (i.e. anticipatory and responsive) N management strategies (Dobermann 2007), such as having a pre-season alternative plan for adjustment of fertilizer rates and times of application in case of delayed rainfall at the pre-determined application time, and using crop-based approaches, such as the LCC, to adjust fertilizer rates during the season according to crop N demand.The highest B : C ratio was in NE7T, which was due to a higher increase in seed yield of maize crop. Thus, it can be concluded that NE7T nutrient management resulted in higher grain yield, total biomass of maize and also maximum net return.

SUMMARY

An agronomic field experiment on “Precision nutrient management in maize (*Zea mays* L.) for higher productivity and profitability through Decision Support Tools”was conducted at ICAR–IARI New Delhi, India during *kharif* 2018. The objective was to enhance seed yield and economics of maize crop trough precision nutrient management. The growth (plant height, dry matter, leaf area, leaf area index), and yield attributes and seed yield were improved under precision nutrient management practices of NE+GS7T, NE6T, NE7T, and NE+GS 6T. The maximum LAR was observed with NE+GS7T at 60 DAS. Maximum cob length was 15.92 cm under NE7T. Plant height was maximum under NE7T (192.5 cm) and NE+GS7T (191.3 cm), similarly maximum dry matter accumulation was in NE7T, which was >22.0% over state recommendation at harvesting stage of maize crop. Grain yield, total biomass of maize was also the highest under NE7T nutrient management (6.2 t/ha). Maximum net return was in NE7T (₹ 75194/ha) and least were in N omission (₹ 12992 to 20451/ha).

REFERENCES

Anonymous. 2018. Statistics at a glance. Department of Agriculture and Cooperation, Ministry of Agriculture & Farmers Welfare. Govt of India

Banerjee M, Bhuiya G S, Malik G C, Maiti D and Dutta S. 2014. Precision nutrient management through use of LCC and Nutrient Expert® in hybrid maize under laterite soil of India. *Journal of Food and Nutrition Science* **2**: 33–36.

Dobermann A, Witt C, Dawe D, Abdulrachman S, Gines G C, Nagarajan R, Satawathananont S, Son T T, Tan P S, Wang G H, Chien N V, Thoa V T K, Phung C V, Stalin P, Muthukrishnan P, Ravi V, Babu M, Chatuporn S, Sookthongsa J, Sun Q, Fu R, Simbahan G C and Adviento M A A. 2007. Site-specific nutrient management for intensive rice cropping systems in Asia. *Field Crops Res*earch **74**: 37–66.

Jat M L, Satyanarayana T, Majumdar K, Parihar C M, Jat S L, Tetarwal J P and Jat R K. 2013. Fertiliser best management practices for maize systems. *Indian Journal of Fertilisers* **9**(4): 80–94.

Majumdar K, Jat M L, Pampolino M, Kumar A, Vishal V, Gupta N, Singh V, Satyanarayana T, Dwivedi B S, Singh V K, Kumar D, Kamboj B R, Sidhu H S, Meena M C and Johnston A.2014. Economics of potassium fertiliser application in rice, wheat and maize grown in the Indo-Gangetic Plains. *Indian Journal of Fertilisers* **8**(5): 44–53.

Neha J and Chandrashekar C P. 2018. Precision nutrient management in maize (*Zea mays* L.) under northern transition zone of Karnataka. *Journal of Farm Sciences* **30**(3): 343–48.

Schirrmann M and Domsch H. 2011. Sampling procedure simulating on-the-go sensing for soil nutrients. *Journal of Plant Nutrition and Soil Science* **174**: 333–43

Singh V, Ramanjit K, Singh B, Singh B and Brar and Kaur A. 2016. Precision nutrient management: A review. *Indian Journal of Fertilisers* **12**(11): 85–100.

Singh C, Raj A, Singh A and Singh S. 2018. Nutrient expert assisted site-specific-nutrient-management: An alternative precision fertilization technology for maize production in Chota-nagpur plateau region of Jharkhand. *Journal of Pharmacognosy and Phytochemistry* **7**: 760–64.