

Effect of Integrated Nutrient Management on Growth, Yield and Nutrient Uptake in Maize under Rainfed *Shivalik* Foot Hills of Jammu Region

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ABSTRACT: A field experiment was conducted under rainfed condition during *kharif* seasons of 2014-2017 at the research farm of Advanced Centre for Rainfed Agriculture (Rakh Dhiansar) of Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, Jammu and Kashmir (UT) to study the effect of integrated nutrient management practices on the growth, yield and nutrient uptake in rainfed maize. Results revealed that the growth parameters of maize crop such as plant height (cm) and dry matter accumulation (q/ha) were significantly influenced by different integrated nutrient management treatments. Among the integrated nutrient management treatments, highest plant height (199.1 cm) and dry matter accumulation (72.8 q/ha) were recorded with application of 50% RFD + 50% N (FYM) followed by 50% RFD + 50% N (crop residues) and 100% RFD + ZnSO₄ 20 kg/ha. Among the integrated nutrient management treatments, highest cob length (16.9 cm), cob girth (14.1 cm), stem girth (6.3 cm), grains/cob (308.9) and 100 seed weight (20.6 g) were recorded with application of 50% RFD + 50% N (FYM) followed by 50% RFD + 50% N (crop residues) and 100% RFD + ZnSO₄ 20 kg/ha. Significantly higher grain yield (1759 kg/ha) was recorded in 50% RFD + 50% N (FYM) over all the other integrated nutrient management treatments except 50% RFD + 50% N (crop residues). However, significantly higher straw yield (4049 kg/ha) was recorded in 50% RFD + 50% N (FYM) over all the integrated nutrient management treatments. Significantly higher total uptake of N, P and K by maize was observed in the treatment comprising of 50% RFD + 50% N (FYM) over all the other integrated nutrient management treatments.

Key words: Growth, integrated nutrient management, maize, nutrient uptake, yield

Introduction

Maize (*Zea Mays* L.) is the third most important food grain crop in India and considered as a most important option for diversifying agriculture in rainfed areas. Maize has high production potential compared to any other cereal crop. Although it can be grown in rainfed areas, the crop often faces moisture stress conditions due to occurrence of mid season or terminal drought. In India, the area, production and productivity of maize is 9.86 mha, 26.26 m tonnes, and 26.64 q/ha (Anonymous 2017). About 12% of the total geographical area of Jammu region is rainfed foot hills, mainly encompassing sub-mountainous tract locally known as *kandi*. In Jammu and Kashmir (UT) maize crop is grown on an area of about 0.30 mha with a production of 0.49 m tonnes and an average productivity of 16.32 q/ha. Maize cultivation is usually practised by marginal and small farmers of *kandi* belt both under plain and hilly tract of low altitude sub-tropical Jammu region (Singh *et al.*, 2020). Majority of the rainfed soils are known for their low fertility status as being prone to varying degrees of soil erosion hazards which results in nutrient mining in these soils. Further, imbalanced and disproportionate use of chemical fertilizers in these soils greatly affects the crop productivity. Thus, the crop productivity in rainfed soils could be improved by ensuring adequate supply of nutrients.

Maize being an exhaustive crop has very high nutrient demand and its productivity mainly depend upon the nutrient management system. Continuous use of chemical fertilizers in an imbalanced proportion results in adverse effects on soil health and also on crop yields. But, the use of organic sources of nutrients alone does not result in spectacular increase in crop yield, due to their low nutrient status. Sustainable yield of maize could be achieved only by applying an appropriate combination of inorganic and organic fertilizers. Maize growers in *Kandi* region generally apply imbalanced chemical fertilizers leading to nutrient deficiencies that further lead to declined organic carbon level in soils (Jamwal, 2000). Therefore, adequate and balanced use of manures and fertilizers is essential for better soil health (Singh *et al.*, 2018). Application of inorganic fertilizers with different sources of organic manures in different proportions has significant role to boost crop growth and productivity by improving nutrient uptake besides maintaining soil nutrient status in rainfed ecosystems. The availability of nitrogen and other nutrients in the soil has been known to be prime factor in determining the yield. Organic sources like farm yard manure (FYM) and crop residues besides containing

nitrogen have capacity to supply macro and other micronutrients considered to be essential for plant growth. Thus, integration of organic and inorganic sources of nutrients is imperative for achieving sustained productivity of rainfed maize. The present investigation was undertaken to evaluate the effect of different integrated nutrient management options on growth, yield and nutrient uptake in maize under rainfed *Shivalik* foot hills of Jammu region.

Material and Method

A field experiment was conducted under rainfed condition at the research farm of Advanced Centre for Rainfed Agriculture (Rakh Dhiansar) of Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, Jammu and Kashmir (UT) situated at 32° 39' N latitude and 74° 53' E longitude at an elevation of 332 m MSL during *kharif* seasons of 2014- 2017. The soil of the experimental site was sandy loam in texture, with a pH of 6.5, low in organic carbon (0.18%) and available nitrogen (178 kg/ha) and medium in available phosphorus (18 kg/ha) and potassium (108 kg/ha). The climate of the region is humid sub-tropical with a mean annual rainfall of 1150 mm. The average *kharif* season rainfall is 753.0 mm distributed from June to October. The mean maximum and minimum temperatures during the crop season were 33.8 °C and 23.2 °C, respectively (Figure 1). The average maximum and minimum relative humidity (%) during the crop season were 76% and 57%, respectively.

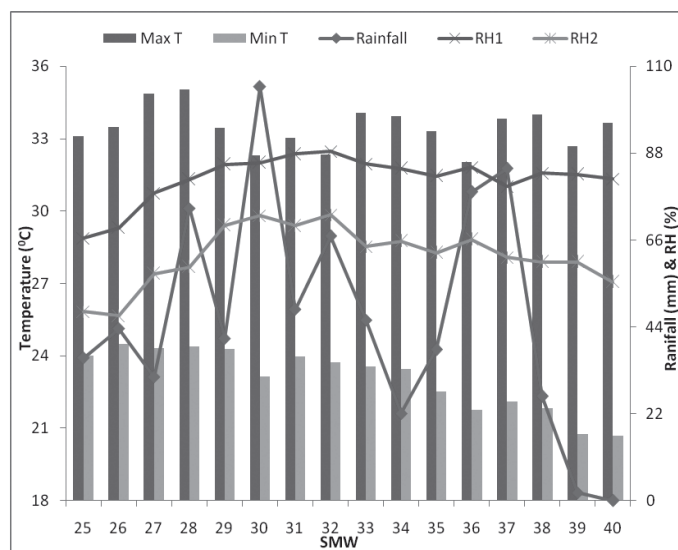


Fig. 1: Meteorological variables during crop growing seasons of *kharif* 2014 to 2017 (pooled data of 4 years)

The experiment was laid out in randomized block design with four replications. The experiment consisted of 10 treatments of inorganic and organic combinations of nutrient sources, viz. T₁: Control (no fertilizer); T₂: 100% recommended fertilizer dose (RFD) (60:40:20 NPK kg/ha); T₃: 50% RFD; T₄: 50% N (crop residue); T₅: 50% N (FYM);

T₆: 50% RFD + 50% N (crop residues); T₇: 50% RFD + 50% N (FYM); T₈: FYM 10 t/ha; T₉: 100% RFD + ZnSO₄ 20 kg/ha and T₁₀: farmers' practice (FYM 4 t/ha + urea 40 kg/ha). Maize local (var. *Mansar*) was sown with the onset of monsoon and harvested in last week of September to 1st fortnight of October during the *kharif* seasons of 2014 to 2017. Maize crop was sown in lines in a unit plot size of 6 m x 4 m with a spacing of 60 cm x 20 cm. The farm yard manure (FYM) and crop residues of wheat were incorporated in the soil one month before sowing. Urea, diammonium phosphate and muriate of potash were applied as a source of nitrogen, phosphorus and potassium, respectively.

Results and Discussion

Effect on growth

A perusal of the pooled data revealed that the growth parameters of maize crop such as plant height (cm) and dry matter accumulation (q/ha) were significantly influenced by different integrated nutrient management treatments. Among the integrated nutrient management treatments, highest plant height (199.1 cm) and dry matter accumulation (72.8 q/ha) were recorded with application of 50% RFD + 50% N (FYM) followed by 50% RFD + 50% N (crop residues) and 100% RFD + ZnSO₄ 20 kg/ha. However, the treatment with 50% RFD + 50% N (FYM) was statistically at par with the treatments comprising of 50% RFD + 50% N (crop residues), 100% RFD + ZnSO₄ 20 kg/ha and 100% recommended fertilizer dose (RFD) for dry matter accumulation (q/ha) (Table 1). This increase in growth parameters may be attributed to increased cell division and photosynthetic activity because of adequate supply of nutrients for longer periods. The results of present study are in agreement with the finding of several other investigators (Kokani *et al.*, 2014; Manasa *et al.*, 2015 and Tomar *et al.*, 2017).

Table 1: Effect of integrated nutrient management on growth and yield attributes of maize (Data pooled over four years)

Treatment	Plant height (cm)	Dry matter accumulation (q/ha)	Cob length (cm)	Cob girth (cm)	Stem girth (cm)	Grains/cob	Seed index 100 seed weight (g)
T1	154.1	49.5	9.2	8.5	3.2	140.5	13.9
T2	174.4	64.3	14.6	12.4	5.4	266.3	19.2
T3	163.8	56.8	13.1	10.9	5.0	207.0	16.5
T4	169.0	52.5	13.4	11.5	4.4	216.7	17.4
T5	170.6	58.3	13.0	11.9	4.3	230.3	18.0
T6	185.2	69.3	15.7	13.4	6.0	278.4	19.7
T7	199.1	72.8	16.9	14.1	6.3	308.9	20.6
T8	171.0	65.0	13.5	12.1	4.0	249.1	19.5
T9	178.9	67.0	15.1	12.9	5.6	271.7	20.3
T10	176.3	63.5	13.6	11.7	5.2	253.4	18.2
CD at 5%	8.21	13.62	0.86	1.19	0.51	18.09	1.27

Effect on yield attributes and yield

Yield attributes, which determine yield, are the resultant of the vegetative development of the plant. All the attributes of yield such as cob length (cm), cob girth (cm), stem girth (cm), grains/cob and 100 seed weight (g) were significantly influenced by the different integrated nutrient management treatments as compared to control during all the years of experimentation. Among the integrated nutrient management treatments, highest cob length (16.9 cm), cob girth (14.1 cm), stem girth (6.3 cm), grains/cob (308.9) and 100 seed weight (20.6 g) were recorded with application of 50% RFD + 50% N (FYM) followed by 50% RFD + 50% N (crop residues) and 100% RFD + ZnSO₄ 20 kg/ha. However, the treatments comprising of 50% RFD + 50% N (FYM) and 50% RFD + 50% N (crop residues) were found to be statistically at par for cob girth (cm), stem girth (cm) and 100 seed weight (g). Control had the lowest values of cob length (9.2 cm), cob girth (8.5 cm), stem girth (3.2 cm), grains/cob (140.5) and 100 seed weight (13.9 g). Similar finding were reported by (Brar, *et al.*, 2001 and Zaremanesh *et al.*, 2017).

Significantly higher grain yield (1759 kg/ha) was recorded in 50% RFD + 50% N (FYM) over all the other integrated nutrient management treatments except for 50% RFD + 50% N (crop residues). However, significantly higher straw yield (4049 kg/ha) was recorded in 50% RFD + 50% N (FYM) over all the integrated nutrient management treatments. Control recorded the lowest values of grain yield (731 kg/ha) and straw yield (2171 kg/ha). Similar findings were also reported by Sharma and Gupta (1998). The increase in yield attributes and yield of maize with application of organic sources of nutrients in integration with inorganic sources may be attributed to the fact that organic sources (FYM and crop residues) being the store house of nutrients also made the release of applied nutrients at its optimum besides improving the soil physical conditions (Gupta *et al.*, 2014). Similarly, the highest rain water use efficiency (RWUE) (2.9 kg/ha-mm) was recorded in the treatment comprising of 50% RFD + 50% N (FYM) over all the other integrated nutrient management treatments except for 50% RFD + 50% N (crop residues). The lowest values of RWUE (1.2 kg/ha-mm) was recorded in control (Table 2).

Table 2: Effect of integrated nutrient management on yield and nutrient uptake (Data pooled over four years)

Treatment	Grain yield (kg/ha)	Straw yield (kg/ha)	RWUE (kg/ha-mm)	Nutrient uptake (kg/ha)		
				N	P	K
T1	731	2171	1.2	26.22	5.65	22.7
T2	1520	3588	2.5	51.12	10.41	43.0
T3	1088	2894	1.8	38.00	7.85	33.4
T4	1059	2719	1.7	36.98	7.74	31.3
T5	1093	2696	1.8	38.31	8.05	31.7
T6	1623	3826	2.7	58.52	11.78	46.4
T7	1759	4049	2.9	67.51	12.79	52.9
T8	1470	3496	2.4	49.21	9.91	40.8
T9	1573	3684	2.6	54.35	10.87	44.1
T10	1401	3222	2.3	46.55	9.31	35.1
CD at 5%	137.58	200.59	0.22	3.54	0.69	2.85

Nutrient uptake

The uptake of N, P and K varied significantly among different integrated nutrient management treatments owing to the varying levels of fertilizer doses as well as sources of nutrients. This might be due to effect of rhizospheric conditions, as a result of varying levels of fertilizer doses and nutrient sources, on the extent and pattern of transformation, mineralization and transport of nutrients to the plant system. Significantly higher total uptake of N, P and K by maize was observed in the treatment comprising of 50% RFD + 50% N (FYM) over all the other integrated nutrient management treatments. However, the treatment with 50% RFD + 50% N (FYM) was followed by 50% RFD + 50% N (crop residues) and 100% RFD + ZnSO₄ 20 kg/ha. The lowest values of total N, P and K uptake were observed

in control (Table 2). The integrated nutrient management treatments (50% RFD + 50% N (FYM) and 50% RFD + 50% N (crop residues)) recorded significantly higher uptake of N, P and K over treatments comprising of inorganic sources of nutrients alone or organic sources of nutrients alone. Higher uptake of N, P and K may be attributed to the favorable effect of incorporation of organic sources along with inorganic nutrients which was earlier reported by Sharma *et al.*, (2013).

From the present study it may be inferred that higher maize yield and nutrient uptake can be obtained with integrated application of organic and inorganic sources of nutrients. The productivity of maize crop can be increased with application of 50% RFD + 50% N (FYM) in rainfed conditions of Jammu and Kashmir.

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