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Effect of different nutrient management practices on growth and yield of late sown *Kharif* maize (*Zea mays* L.) in western Uttar Pradesh

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Abstract
The field experiment was conducted during *kharif* season of 2015, at the experimental farm of IFTM University, Lodhipur Rajput, Delhi Road NH-24, Moradabad, Uttar Pradesh. Thirteen treatment combinations *viz.*, T_1 (Control), T_2 (120% RDF NPK), T_3 (120% RDF NPK + B), T_4 (120% RDF NPK + Zn), T_5 (120% RDF NPK + B + Zn), T_6 (100% RDF NPK), T_7 (100% RDF NPK + B), T_8 (100% RDF NPK + Zn), T_9 (100% RDF NPK + B+ Zn), T_{10} (75% RDF NPK + 10 t FYM ha^{-1}), T_{11} (75% RDF NPK + B + 10 t FYM ha^{-1}), T_{12} (75% NPK + Zn + 10 t FYM ha^{-1}), and T_{13} (75% RDF NPK + Zn + B +10 t FYM ha^{-1}) were taken for this investigation to find out suitable nutrient management practices for the growth and yield of maize crop. Maximum values of growth parameters, yield and yield attributes were observed with T_{13} (75% NPK+B+Zn+FYM 10 t ha^{-1}) and next to the best treatment was T_{12} (75% NPK + Zn + FYM 10t ha^{-1}). Maximum plant height at 30, 60 DAS and at harvest stage (35.67, 190.10, 222.00 cm), fresh weight (101.33, 337.33, 402.00 g), dry weight (28.25, 195.67, 284.33 g) at 30, 60DAS and at harvest stage, number of cobs (1.93 plant^{-1}), cob length (39.67 cm) and number of grains (614.23 cob^{-1}) were recorded with T_{13}(75% NPK+B+Zn+10t FYM ha^{-1}). Maximum grain yield (26.42 q ha^{-1}), stover yield (45.15 q ha^{-1}) and harvest index (36.93%) were also recorded with T_{13} (75% NPK + B + Zn + 10t FYM ha^{-1}).

Keywords: Maize, NPK, FYM, growth parameters and grain yield

Introduction
Maize (*Zea mays* L.), crop also; called "queen of cereals" is the third most important crop in India after rice and wheat. Globally, India stands 5th rank in acreage and 8th rank in production of maize. It is cultivated on 9.7 million hectares with a production of 24.3 million tones having productivity of 26.76 quintals ha^{-1} (MOA, 2014) [7]. Maize being an exhaustive crop has very high nutrient demand and its productivity mainly depend upon nutrient management system. The use of major nutrients alone fail to sustain yield levels due to increasing deficiency of secondary and micronutrients and alteration in the physical and chemical properties of soil which is unfavorable for crop growth. In addition severe boron and zinc deficiency is one of these incidences that also causes low yield of maize. Micronutrients are those trace elements which are necessary for the normal healthy growth and reproduction of plants and animals. Among the micronutrients boron (B) deficiency is the second most widespread micronutrient problem (Alloway, 2008) [2]. Boron is important for crop production from the both point of view, its effects in deficiency and excess. When B is deficient plant root systems are often stunted and less effective. Deficiencies of B occur in a wider range of crops and climatic

conditions than deficiencies of any other trace elements. On the other hand a wide range of crops are affected by zinc deficiency, including cereals. When crops have a deficient supply of Zn, yield reduced and quality of the crop product may also suffer. Losses up to 30% in the yield of cereal grains in crops such as maize, wheat and rice have been observed (Alloway, 2001) [1]. Zinc is required in small but critical concentrations to allow several key plant physiological functions in plants.

Over reliance on use of chemical fertilizers has been associated with declines in soil physical and chemical properties and crop yield (Hepperly *et al.*, 2009) [4] and significant land problems, such as soil degradation due to over exploitation of land and soil pollution caused by high application rates of fertilizer and pesticides application (Singh, 2000) [8]. The organic sources besides supplying N, P and K also make unavailable sources of elemental nitrogen, bound phosphates, micronutrients, and decomposed plant residues into an available form to facilitate to plant for absorb the nutrients. But, it is also the fact that optimum yield level of maize production cannot be achieved by using only organic manures because of their low nutrient content and availability in short period and on the other hand dependency on chemical fertilizers alone may not provide a viable economic option. Therefore, to maintain soil productivity on a sustainable basis an integrated nutrient management approach, using both organic and inorganic sources of nutrients should be adopted. In the present context, the use of manures must be given prime importance and fertilizer use should be limited to balance the nutrient requirement of the crops. In order to sustain soil fertility and to reap rich harvests of maize, it is imperative that both organic manure and mineral nutrition have to be given adequate attention under irrigated conditions. Keeping these points in view, the present study was under taken.

Materials and Methods

The field experiment was conducted during *kharif* season of 2015, at the experimental farm of IFTM University, Lodhipur Rajput, Delhi Road NH-24, Moradabad, Uttar Pradesh. The district Moradabad lies between 28°21´ to 28°16´ North latitude and 78°4´ to 79° East longitude above mean sea level of 193.23 meters. The experimental plots have uniform topography with homogenous fertility and soil characteristics typical to suit Maize crop cultivation. The fields were fairly leveled and had good drainage having assured irrigation facility. The soil of the experimental site was sandy loam in texture, having pH= 7.0-7.5 with 0.6 per cent of organic carbon. Thirteen treatment combinations *viz.*, T_1 (Control), T_2 (120% RDF NPK), T_3 (120% RDF NPK + B), T_4 (120% RDF NPK + Zn), T_5 (120% RDF NPK + B + Zn), T_6 (100% RDF NPK), T_7 (100% RDF NPK + B), T_8 (100% RDF NPK + Zn), T_9 (100% RDF NPK + B+ Zn), T_{10} (75% RDF NPK + 10 t FYM ha^{-1}), T_{11} (75% RDF NPK + B + 10 t FYM ha^{-1}), T_{12} (75% NPK + Zn + 10 t FYM ha^{-1}), and T_{13} (75% RDF NPK + Zn + B +10 t FYM ha^{-1}) with different levels of NPK with and without FYM, Zn and Boron were taken for this investigation. These treatments were tried by using variety Naveen (hybrid) in Randomized Complete Block Design (RCBD) with three replications. Recommended doses of fertilizer (RDF) NPK (120:60:40 kg ha^{-1}), Zinc (10 kg ha^{-1}) and Boron (10 kg ha^{-1}) were applied during *kharif* maize cultivation. Half doses of nitrogen, full doses of phosphorus, potassium, zinc and boron were applied as basal form. While remaining half dose of nitrogen was applied at teaseling stage according to the treatments. As per the treatments the FYM was applied and incorporated into soil three weeks before sowing and other nutrient sources like N, P, K, B and Zn were supplied through urea, DAP, MOP, borax and zinc sulphate, respectively. The seeds were sown at the rate of 20 kg ha^{-1} with the spacing of 50cm x 20cm. Irrigation was given as and when required depending upon soil moisture. The growth and yield parameters were recorded at harvest by following standard procedures.

Results and Discussion

The results obtained from the present investigation are summarized below:

Effect on growth

There was significant effect on plant height and total dry matter production in maize at harvest due to different nutrient management practices. Combined application of 75% RDF NPK + Zn+ B +10 t FYM ha^{-1}) *i.e.* T_{13}, recorded higher growth parameters *viz.*, plant height (222.00 cm) and total dry matter production (284.33 g/plant) followed by T_{12} (75% RDF NPK + Zn + 10 t FYM ha^{-1}) 213.00cm and 263.67g/plant, respectively and T_{11} (75% RDF NPK + B + 10 t FYM ha^{-1}) 205.67 cm and 251.67g/plant, respectively. This may be due to the fact that organic matter functioned as source of energy for all soil micro flora, which brings about transformations of inorganic nutrients held in the soil or applied in the form of fertilizers to readily available form that is utilized by growing plants. Among the micronutrients Boron and ZnSO4 act as imperative action for growth and plants development [12]. Jahiruddin *et al*. reported that B and Zn showed a significant influence on the production of dry matter. Lowest growth parameters *viz.*, plant height (163.00 cm) and total dry matter production (180.33 g/plant) were noticed in the treatment receiving 100 per cent recommended dose of NPK through chemical fertilizer (150:75:40 kg/ha) i.e. T_1 (Control) (Table1). The lower growth and yield parameters may be due to the volatilization or leaching losses leads to low availability of nutrients. The results of present investigation on overall improvement in crop growth were in close agreement with Balyan *et al.* (2006) [3].

Effect on yield

Application of T_{13} (75% RDF NPK + Zn+ B +10 t FYM ha^{-1}) recorded significantly higher grain yield and yield parameters *viz.*, number of grains per cob (614.23), grain yield (26.42 q/ha), and stover yield (45.15 q/ha) and it was at par with the application ofT_{12} (75% RDF NPK + Zn+ 10 t FYM ha^{-1}) 569.57, 24.28 q/ha, and 43.72q/ha, respectively. Significantly lower yield parameters *viz.*, number of grains per cob (195.83), grain yield (15.01q/ha) and stover yield (26.51q/ha) were noticed with the treatment T_1 (Control) receiving 100 per cent recommended dose of NPK through chemical fertilizer (150:75:40 kg/ha) (Table 2). However, harvest index was found to be non-significant during this investigation. The increased grain yield may be due to higher number of grains per cob (Iman *et al.*, 2002) [5]. The nutrient supplying capacity of soil was improved by the application of various sources of nutrients such as organic manures and inorganic fertilizers besides improvement in physical, chemical and biological properties of soil. The availability of major and micro nutrients was depending upon the nutrient releasing pattern of these organic and inorganic sources. The improvement in grain and biological yield of maize is also attributed to complementary role of boron and zinc in the reproduction and

vegetative stage of plants. Usually, micronutrients are required in minute amounts but impart significant effects on metabolism by working synergistically with hormones and enzymes in normal functionality of system. Application of 75% RDF NPK + Zn+ B +10 t FYM ha^{-1}might have supplied the adequate amount of available nutrients at different stages due to release of sufficient amount of nutrients by mineralization at a constant level that result in higher plant growth and dry matter production which leads to increasing in yield and yield attributes. The findings of Zaman *et al.* (1998) [9] confirm the results.

Table 1: Plant height and dry matter production as influenced by integrated nutrient management in maize

Treatments	Plant height (cm)	Total dry matter production (g/plant)
T_1 (Control)	163.00	180.33
T_2 (120% RDF NPK)	171.67	196.67
T_3 (120% RDF NPK + B)	177.33	206.67
T_4 (120% RDF NPK + Zn	182.67	220.33
T_5 (120% RDF NPK + B + Zn)	188.67	229.67
T_6 (100% RDF NPK)	169.00	186.33
T_7 (100% RDF NPK + B)	175.67	195.00
T_8 (100% RDF NPK + Zn)	177.99	203.33
T_9 (100% RDF NPK + B+ Zn)	185.93	210.33
T_{10} (75% RDFNPK + 10 t FYM ha^{-1})	194.47	236.33
T_{11} (75% RDF NPK + B + 10 t FYM ha^{-1})	205.67	251.67
T_{12} (75% RDF NPK + Zn + 10 t FYM ha^{-1})	213.00	263.67
T_{13} (75% RDFNPK + Zn + B +10 t FYM ha^{-1})	222.00	284.33
S.E.±	1.293	1.800
C.D. (P=0.05)	3.798	5.286

Table 2: Plant height and dry matter production as influenced by integrated nutrient management in maize

Treatments	No of grains cob^{-1}	Grain yield (q ha^{-1})	Stover yield (q ha^{-1})	Harvest index (%)
T_1 (Control)	195.83	15.01	26.51	33.79
T_2 (120% RDF NPK)	204.90	18.31	36.72	31.95
T_3 (120% RDF NPK + B)	221.17	16.43	35.35	30.57
T_4 (120% RDF NPK + Zn	277.83	21.51	40.72	34.68
T_5 (120% RDF NPK + B + Zn)	390.30	23.84	42.36	35.66
T_6 (100% RDF NPK)	238.37	19.99	40.77	33.65
T_7 (100% RDF NPK + B)	284.03	20.14	39.52	33.68
T_8 (100% RDF NPK + Zn)	295.83	20.94	39.63	34.54
T_9 (100% RDF NPK + B+ Zn)	391.60	21.47	42.59	33.57
T_{10} (75% RDF NPK + 10 t FYM ha^{-1})	400.13	22.14	45.59	32.68
T_{11} (75% RDF NPK + B + 10 t FYM ha^{-1})	418.43	23.03	45.33	35.27
T_{12} (75% RDF NPK + Zn + 10 t FYM ha^{-1})	569.57	24.28	43.72	35.71
T_{13} (75% RDF NPK + Zn + B +10 t FYM ha^{-1})	614.23	26.42	45.15	36.93
S.E.±	25.84	1.592	1.630	1.558
C.D. (P=0.05)	75.872	4.674	4.787	NS

Conclusion

Present study highlighted the importance of integrated nutrient management with the application of micronutrients. Usually the Indian soils are deficient of micronutrients like boron and zinc. The field trial thus revealed that an integrated supply of farm yard manure with chemical fertilizers and micronutrients (boron and zinc) resulting in better growth and grain yield maize.

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