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Effect of integrated nutrient management with *Azotobacter* on growth and yield on maize (*Zea mays* L.) Var. K-65

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Abstract
A field experiment was conducted to study the effect of INM with *Azotobacter* on growth and yield of maize var. K-65 at Crop research farm Department of Soil Science & Agriculture Chemistry, Naini Agriculture Institute, SHUATS Prayagraj. The experiment was laid out in randomized complete block design with eight treatments each replicated three times. Analysis of variance showed that growth and yield were significantly affected with treatments. The application of T8 @ 100% NPK + @ 100% *Azotobacter* gave significantly higher plant height 170.70cm, number of leaves plant-1 15.85 and leaf length 57.47cm, dry weight of plant 173.36g, length of cob 17.73cm, number of grains cob-1 308.76, number of grains cob-1 204.57, test weight g 215.76 and grain yield 38.42 q ha-1.

Keywords: INM, *Azotobacter*, growth, yield and maize

Introduction
Maize is one of the most important cereal crops in the world it is a member of family Graminae (Poaeceae) sub family Panicoideae. Maize is also known as „Queen of cereals‟ and kind of fodder maize has been usually considered as poor Man‟s crops and occupying the place in the rich communities due to its multifarious uses as industrial food and feed crops. Maize grain contains about 72% starch, 10% protein, 4.8% oil, 5.8% fibre, 3.0% sugar and 1.7% ash. Along with this, it is rich in vitamin A, vitamin E, nicotinic acid, riboflavin and contains fairly high phosphorus than rice and sorghum. Its fodder and hay contain 7-10% protein, 15-36% fibre, 2.09 to 2.62% ether extract, 0.42- 0.70% Calcium, 0.28-0.29% phosphorus, 0.45% Magnesium, 1.34% Potassium and 56% carbohydrate, therefore, it has very nutritive fodder and hay. Besides food grain, fodder and feed, it has prime importance in textile, starch and dye industries Rai, (2006) [14]. Maize is one of the world‟s leading crop cultivated over an area of 139 m ha- 1.with a production of about 600 mt. of grain. USA leads the largest area, followed by Brazil, China, Mexico and India. Maize is grown in almost all states of India occupying an area of 6 m ha-1 with the production and productivity of 9.7 mt. and 1.7 t ha-1, respectively Kumar *et al*., (2007) [11, 12]. Maize high genetic yield potential than other cereal crops. Hence it is called as, miracle crop‟ and also being a C4 plant, it is very efficient in converting solar energy in to dry matter. Maize (*Zea mays* L.) has becoming very popular cereal crop in India because of the increasing market price and high production potential of hybrid varieties in both irrigated as well as rain fed conditions. More ever in irrigated areas farmers produce the income equal to the cash crops such as sugarcane, onion, cotton, *etc*. in comparatively short time period of 120-130 days by cultivating hybrid maize varieties. m and applied the multivariate statistical approach to optimize the extraction conditions. The analytical method showed high extraction yields for the determination of this compound in a complex matrix such as tissue. Moreover, the extraction procedure was very fast and it was possible to perform on a small sample aliquot. The limit of quantification value in fish tissue was 0.083 mg g^{-1} and the limit of detection was 0.016 mg g^{-1}. Hence the trend of replacing some cash crops with maize in intensive cultivation is observed in present condition Kimdu *et al.*, (2009) [10].

Nitrogen is a vitally important for plant nutrient. Nitrogen is essential constituent of protein and is present in many other compound of great physiological importance in plant metabolism nitrogen is called a basic constituent of life.

Nitrogen also impart vigorous vegetative growth dark green colour to plant and it produce early growth of maize. Nitrogen governs the utilization of potassium, phosphorus and other elements in maize crop Singh *et al.*, (2010) [15].

Phosphorus has a great role in energy storage and transfer and closely related to cell division and development of maize. Phosphorus is a constituent of nucleic acid, phytin and phospho-lipid. Phosphorus compound act as “energy currency within plants. Phosphorus is essential for transformation of energy, in carbohydrate metabolism, in fat metabolism, in respiration of plant and early maturity of maize Singh *et al.*, (2010) [15].

Biofertilizers are low cost, renewable sources of plant nutrients which supplement chemical fertilizers. These are nothing but selected strains of beneficial soil microorganisms cultured in the laboratory and packed in a suitable carrier. They can be used either for seed treatment or soil application. Bio fertilizers generate plant nutrients like nitrogen and phosphorous through their activities in the soil or rhizosphere and make available to plants in a gradual manner. Bio fertilizers are gaining momentum recently due to the increasing emphasis on maintenance of soil health, minimize environmental pollution and cut down on the use of chemicals in agriculture. In rain fed agriculture, these inputs gain added importance in view of their low cost, as most of the farmers are small and marginal and cannot afford to buy expensive chemical fertilizers. Bio fertilizers are also ideal input for reducing the cost of cultivation and for practising organic farming Paramasivan *et al.*, (2011) [13].

NPK fertilizers on the Zn and P content of maize ear-leaf, the P and Zn interactions with the application of Zn as ZnS04 and P as NPK 15-15-15 in maize plant and the Zn and P up take at ear-leaf stage in the maize plant. Top soils from three identified profiles in a top sequence were sampled for general characterization and zinc contents. The 4 X 2 X 3 factorial potted experiment was laid out in an RCB design using maize as the test crop on 10 kg-1 of the top soils of each of the profiles. Phosphorus was applied with nitrogen (N) and potassium (K) as NPK 15-15-15 at the rate of 120 kg N ha- 1 and Zn at 0, 15, 30 and 45 ppm plot (i.e. 0, 15, 30 and 45 kg Zn ha-1). Maize ear-leaves were analyzed for P and Zn contents at tasseling. At maturity, the shoots and roots were harvested, weighed and recorded as dry matter yield. Results obtained showed that the soils were high in pH, total N, K and all other measured exchangeable cations, but low in P and Zn. The applied fertilizer (NPK), had significant ($P< 0.05$) effects on the root and shoot dry matter yield of maize plants grown on the soils at the lowest part of the slope (Profile C) only. There was a linear positive correlation (r = 0.072) between NPK and Zn in the ear-leaves of plant grown on profile B (mid - slope) Aduloju *et al.*, (2013) [2].

Application of increasing rate of NPK, delayed Number of days taken to tasseling, silking and maturity of the crop. The plant height was significantly affected by different rates of NPK. Treatment F3 (250-110-85 kg ha-1) of NPK produced tallest plants than two other treatments in both the varieties. Too low or high NPK levels reduced the yield and yield parameters of maize crop. Treatment F2 (175-80-60 kg ha-1) seems to be the most appropriate level to obtain maximum grain yield under the prevailing conditions. Application of NPK beyond treatment F2 (175-85-60 kg ha-1) seems to be an un-economical and wasteful practice. Varieties (Golden & Sultan) seem to have similar production potential under uniform and similar growing condition Asghar *et al.*, (2010) [5].

Materials and Methods

The experiment was conducted during *kharif season* of 2018-19 at Crop research farm Department of Soil Science and Agriculture Chemistry, Naini, Agriculture Institute, SHUATS Prayagraj. The experimental site is located in the sub – tropical region with 25o 27o N *latitude* 81o 56o E longitudes and 98 meter the sea level *altitudes.* The experiment was laid out in a RBD with three levels of NPK and *Aztobacter* each consisting of three replicates. Maize (*Zea mays L.*) was sown in Kharif season plots of size 2 x 2 m with row spacing 60 cm and plant to plant distance 20 cm. The treatment consisted of nine combination of T0 Control, T1 @ 0% (NPK) + @ 50 % Azotobacter, T2 @ 0% (NPK) + @ 100 % Azotobacter, T3 @ 50 % (NPK) + @ 0 % Azotobacter, T4 @ 50% (NPK) + @ 50 % Azotobacter, T5 @ 50 % (NPK) + @ 100 % Azotobacter, T6 @ 100% (NPK) + @ 0% Azotobacter, T7 @ 100 % (NPK) + @ 50 %*Azotobacter* and T8 @ 100% (NPK) + @ 100% Azotobacter. The observations were taken on different plant characters *viz.,* plant height (cm), number of leaves plant-1, leaf length (cm), dry weight of plant (g), length of cob, number of grains cobs-1, test weight, and Grain yield (q ha-1).

Results and Discussion

Observations regarding the response of different treatments on growth and grain yield (q ha-1) *viz.,* plant height (cm), number of leaves plant-1, leaf length (cm), dry weight of plant (g), length of cob, number of grains per cobs, test weight and grain yield (q ha-1) of maize are given in table 1 and fig 1 There was significant difference between the treatments. The maximum plant height (170.70cm), number of leaves per plant (15.85) and leaf length (57.47cm) was recorded in treatment T8 @ 100% (NPK) + @ 100% *Azotobacter* and minimum plant height (106.30cm), number of leaves-1 (7.78) and leaf length (43.68) was found in control T0 Control.

The maximum dry weight of plant 173.36g was observed by the application of T8 @ 100% NPK + @ 100% *Azotobacter* whereas the lowest value of dry weight of plant 133.38g was observed in treatment T1 *i.e.,* Control. The maximum length of cob 17.73cm was observed by the application of T8 @ 100% NPK + @ 100% *Azotobacter* whereas the lowest value of length of cob 10.26 was observed in treatment T1 *i.e.,* Control. The maximum number of grains cob-1 308.76 was observed by the application of T8 @ 100% NPK + @ 100% *Azotobacter* whereas the lowest value of number of grains cob-1 204.57 was observed in treatment T1 *i.e.,* Control. The maximum test weight g 215.76 was observed by the application of T8 @ 100% NPK + @ 100% *Azotobacter* whereas the lowest value of test weight g 188.46 was observed in treatment T1 *i.e.,* Control. The maximum grain yield 38.42q ha-1 was observed by the application of T8 @ 100% NPK + @ 100% *Azotobacter* whereas the lowest value of grain yield q ha-1 16.54 was observed in treatment T1 *i.e.,* Control.

Table 1: Effect of Integrated Nutrient Management with *Azotobacter* on growth and yield of Maize (*Zea mays* L.) var. K-65

Treatments	Plant height (cm)	Number of leaves plant-1	Leaf Length (cm)	Dry Weight of plant (g)	Length of cob	Number Of grains per cobs	Test weight	Grain yield (q ha-1)
T0:Control	106.30	7.78	43.68	133.38	10.26	204.57	188.46	16.54
T1:@ 0% (NPK) + @ 50 % Azotobacter	138.99	8.61	44.07	140.68	11.74	218.72	195.47	18.88
T2:@ 0% (NPK) + @ 100 % Azotobacter	129.18	8.50	45.56	144.66	12.74	266.52	198.66	20.23
T3:@ 50% (NPK) + @ 0 % Azotobacter	132.43	9.39	46.60	153.13	15.69	238.60	205.49	22.25
T4:@ 50% (NPK) + @ 50 % Azotobacter	134.34	9.60	46.99	160.53	15.48	249.89	206.52	23.84
T5: @ 50% (NPK) + @ 100 % Azotobacter	163.70	11.76	47.70	163.44	16.41	267.56	208.56	24.18
T6:@ 100% (NPK) + @ 0 % Azotobacter	165.49	12.75	52.75	166.68	17.18	276.37	210.66	33.54
T7:@ 100% (NPK) + @ 50% Azotobacter	166.93	12.88	53.58	172.64	17.48	290.43	214.51	34.10
T8:@ 100% (NPK) + @ 100% Azotobacter	170.70	15.85	57.47	173.36	17.73	308.76	215.76	38.82
F-Test	S	S	S	S	S	S	S	S
C.D. at 0.05%	10.188	0.458	0.717	0.760	1.517	1.221	0.596	1.381
S.Ed. (+)	4.806	0.216	0.338	0.358	0.715	0576	0.281	3.091

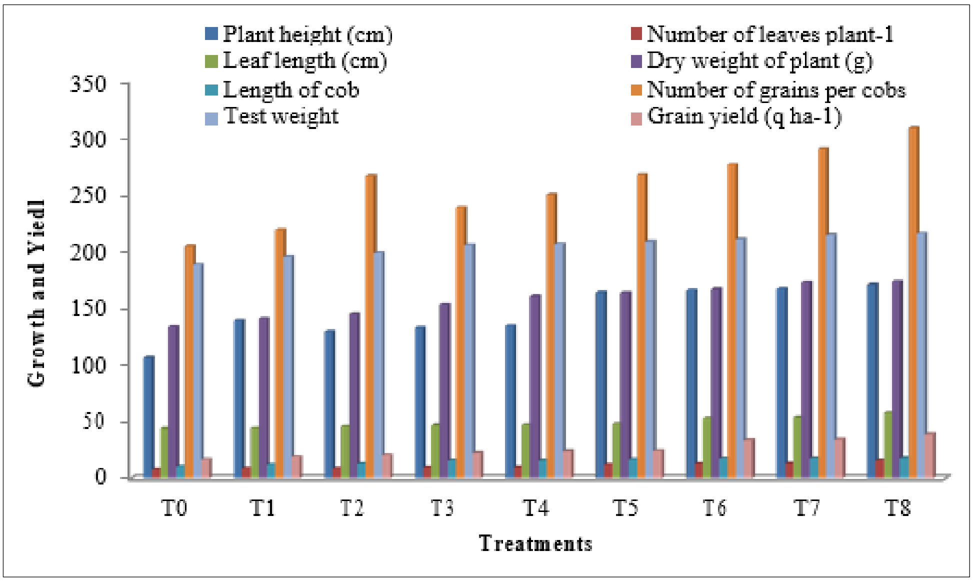

Fig 1: Effect of integrated nutrient management with *Azotobacter* on growth and yield of maize (*Zea mays* L.) var. k-65

Conclusion

It is concluded that the various levels of integrated nutrients use from different sources in the experiment, The combined application of T8 @100% (NPK) + @ 100% *Azotobacter* was found to be the best in increasing growth, yield of maize and physical and chemical properties of soil. Since the result is based on one season experiment, further trial is needed to substantiate the result.

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