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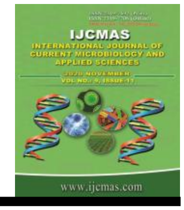

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Effect of Nitrogen and Iron Levels on Growth and Yield of Rabi Hybrid Maize (*Zea mays* L.)

Dhanush Reddy*, Pavan Ganesh, Ammisetty Saisravan and Joy Dawson

Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj – 211007, Uttar Pradesh, India

**Corresponding author*

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A B S T R A C T

The treatments consisted of soil application of three nitrogen levels (100, 120, 140 kg/ha) and three Iron levels (10, 20, 30 kg/ha). There were 10 treatments each replicated thrice. The experiment was laid out in Randomized Block Design. Maximum result showed in growth parameters *viz.* plant height, Number of leaves per plant, Dry matter production, were recorded highest inT_9 nitrogen 140 kg/ha + Fe 30 kg/ha and yield parameters *viz.* number of cobs per plant, number of grains per cob, test weight, Grain yield, were recorded maximum with the application of T_9 140 kg/ha + Fe 30 kg/ha. B:C ratio were recorded with the application of$T_7$140 kg/ha + Fe 10 kg/ha.

Introduction

Maize (*Zea mays* L.) the 'queen of cereals', popularly known as corn, is one of the most important cereals of the world. The term maize, which has been derived from an arawik-exils word "mahiz", also known as Indian corn maize, as it is grown in various agro climatic conditions ranging from temperate to tropical regions from sea level to an altitude of 2500 meters thought out the world. Maize in terms of area 157.38 million hectares and production 1.15 billion tonnes globally. India ranks fourth in an area and seventh in terms of in production, it is grown in an area of 9.47 million hectares with a production of 28.72 million tonnes. The average global productivity of crop is 3.78 tonnes/ha against the average productivity of 1.7 tonnes/ha in India. In India, maize is cultivated in the states of Karnataka, Maharashtra, Andhra Pradesh, Bihar, Rajasthan, Madhya Pradesh, Gujarat, Chattisgarh, Tamil Nadu and Uttar Pradesh (Anon., 2018). Recent studies have shown that maize can be successfully grown during Rabi in many parts of the country due to evolution of new genotypes. In India, maize has been widely cultivated as a rainfed crop during kharif season but it is also being successfully grown during Rabi under irrigated conditions with higher productivity due to its timely water availability and higher fertilizer use efficiencies Patel *et al.,* (2006).

Nitrogen is a structural unit of amino acids and amides. Amino acids construction and nitrate reduction processes are depended to nitrogen (Motosharezaadeh and Malakooti, 2000). Nitrogen is the key element in crop growth and is the most limiting nutrient in Indian soil. The paramount importance of nitrogen for increasing the yield has been widely accepted. Nitrogen influences the quality of product by improving the level of protein, succulence and palatability. Nitrogen plays an important role in synthesis of chlorophyll as well as several amino acids. Corn is heavily consumer of plant nutrient. An adequate supply of Nitrogen is associated with dark green colour, high photosynthetic activity and vigorous growth. An excess of nitrogen can delay the crop maturity and the optimum use of nitrogen in conjunction with other nutrients i.e. N, P, K, cause timely maturity of crops such as corn. When N supplies are sufficient, carbohydrates will be deposited in vegetative cells causing them to thicken. Thereby, N is the motor of plant growth and makes up 1 to 4% of dry matter of the plants (Taiz and Zeiger, 2010). It also mediates the utilization of P, K, and other elements in plants (Onasanya *et al.,* 2009). It is widely accepted that crops grown on soils deficient in N, exhibit very distinctive N deficiency symptoms such as poor growth, chlorosis, necrosis and causes disorder in many physiological/biochemical characteristics of plants (Taiz and Zeiger, 2010). The use of N-fertilizers along with other nutrients has been suggested to enhance the crop productivity (Marschner, 1995). The response of maize plant to application of N fertilizers varies from variety to variety, location to location and also depends on the availability of the nutrients (Onasanya *et al.*, 2009).

Fe is a necessary trace element that takes place in several redox states, eagerly accepting and donating electrons, which confer the ability to function as a cofactor for numerous plant proteins that contribute in key metabolic pathways (García Bañuelos *et al.*, 2014). Iron is extensively used to increase yield and their concentration as well as quality in crops. They can be applied in different way such as foliar spray, soil application (sprayed over soil surface or applied in soil) and seed application method. There is another widely used method to apply Fe fertilizers which is soil application. It is believed to be an efficient way of correcting symptoms of soil Zn or Fe deficiency, significantly improved grain yield, biomass and harvest index in rice as well as enhancing Zn concentration and N in maize grain (Wang *et al.,* 2012). Therefore, biofortification of plants through increase of iron availability in soil can be considered as economic and sustainable management to cope with iron shortage in diet (Zuo and Zhang, 2001).

Materials and Methods

A field experiment was conducted during rabi season of 2019, at Crop research farm of Department of Agronomy at Sam Higginbottom University of Agriculture, Technology, and Sciences, Prayagraj which is located at 25^o 24' 42" N latitude, 81^o 50' 56" E longitude and 98 m altitude above the mean sea level (MSL). To assess the "Effect of Nitrogen and Iron levels on growth and Yield of Maize (*Zea mays* L.)" The experiment was laid out in Randomized Block Design comprising of 10 treatments which are replicated thrice. Each treatment net plot size is 3m x3m. First treatment (T_1) Nitrogen 100 kg/ha + Fe 10 kg/ha, (T_2) Nitrogen 100 kg/ha + Fe 20 kg/ha,(T_3) Nitrogen 100 kg/ha + Fe 30 kg/ha, (T_4)Nitrogen 120 kg/ha + Fe 10 kg/ha (T_5) Nitrogen 120 kg/ha + Fe 20 kg/ha, (T_6) Nitrogen 120 kg/ha + Fe 30 kg/ha,(T_7) Nitrogen 140 kg/ha + Fe 10 kg/ha,(T_8) Nitrogen 140 kg/ha + Fe 20 kg/ha, (T_9) Nitrogen 140 kg/ha + Fe 30 kg/ha and (T_{10}) Farmer's practice (100:60:40) kg/hais categorize as farmer practice 100 N kg/ha through urea and DAP, 60 kg/ha P_2O_5 through DAP and 40 kg/ha K_2O through Muriate of Potash. Fertilizer application nitrogen doses of 100, 120, 140 kg/ha was worked out for the maize crop and iron doses are 10, 20, 30 kg/ha accordingly were calculated and applied respectively. The sources used for applying N, P and K were urea, di-ammonium phosphate (adjusted for its N content) and muriate of potash, respectively. ferrous sulphate was used to supply Fe respectively. Fertilizer applications were made as per the treatments. Full dose of phosphorus, potash and half dose of nitrogen were applied at sowing as basal application. The remaining dose of nitrogen was top dressed at 30 DAS and 60 DAS depending upon the occurrence of rains. full dose of iron Fertilizer application rates was applied as basal application. The crop was harvested close to ground with the help of sickle and plant were tied in bundles and kept for sun drying on threshing floor for few days. After separation of the cobs from plants, they were dehusked and shelled through cob Sheller and produce of each plot was winnowed, weighed and samples were taken for laboratory and statistical method analysis of Gomez and Gomez (1984). The benefit: cost ratio was worked out after price value of grain with straw and total cost included in crop cultivation. After through field preparation initial soil samples were taken to analyse for available major nutrients. The type of soil in experimental field is sandy clay. The pH of the experimental field was 7.3, EC of 0.29 dSm^{-1}, organic carbon was 0.46%. The N status of the experimental field was low (215 kg ha^{-1}), medium in available P (12 kg ha^{-1}) while available K status was in higher range (232 kg ha^{-1}). Growth parameters viz. plant height (cm), No. of leaves per plant, dry matter accumulation (g/plant) were recorded manually on five randomly selected representative plants from each plot of each replication separately as well as yield and yield attributing character viz. grain yield t/ha, No. of cobs per plant, no of grains per cob and test weight were recorded as per the standard method. The oxidizable organic carbon and pH was determined by Jackson (1973), Soil texture by the Bouyoucos Hydrometer Method Bouyoucus, (1927). Available nitrogen was determined by Subbiah and Asija (1956), Available phosphorus was determined by Olsen *et al.*, (1954) and available potash was determined by Flame photometric method, Jackson (1973).

Results and Discussion

Effect on growth parameters: It is evident from Table 1 that plant height measured increased with advancement in crop growth. At harvest the treatment T_9 (Nitrogen 140 kg/ha + Fe 30 kg/ha) recorded maximum height of 154.90 cm. Nitrogen T_8 (140 kg/ha + Fe 20 kg/ha) were found statistically at par to T_9 (140 kg/ha + Fe 30 kg/ha). The highest plant height in treatment T_9The probable reason for increase in plant height is due to soil application of Nitrogen 140 kg/ha and Fe 30 kg/ha might be attributed due to maize grain yield was significantly increases N rate increased and maximum figure was obtained due to addition of 140 kg N. as reported by El-Naggar and Amer (1999) and increasing nitrogen fertilization rates up to 140 Kg N leads to a significant increase in plant height, weight of leaf ear, ear weight, grain weight of ear, 100 grain weight, straw and grain yield of maize. Observed by the qEl-Douby *et al.*, (2001) with iron application. Iron has its role in starch formation and protein synthesis as well as maintenance and synthesis of chlorophyll in plants. The increase in availability of Iron to plant might have stimulated the metabolic and enzymatic activities there by increasing the growth of crop. Similar results were obtained by Monukumar *et al.*, (2019).

Table.1 Effect of nitrogen and iron levels on growth parameters of rabi hybrid maize var. 'RHM- 4212' at harvest

S.No	T.no	Treatments	Plant height (cm)	No. of leaves/plant	Dry weight (g/plant)
1	T_1	Nitrogen 100 kg/ha + Fe 10 kg/ha	138.40	11.00	186.61
2	T_2	Nitrogen 100 kg/ha + Fe 20 kg/ha	139.67	11.06	187.31
3	T_3	Nitrogen 100 kg/ha + Fe 30 kg/ha	140.97	10.93	189.44
4	T_4	Nitrogen 120 kg/ha + Fe 10 kg/ha	142.10	10.80	194.28
5	T_5	Nitrogen 120 kg/ha + Fe 20 kg/ha	143.52	10.93	195.41
6	T_6	Nitrogen 120 kg/ha + Fe 30 kg/ha	146.90	11.13	198.19
7	T_7	Nitrogen 140 kg/ha + Fe 10 kg/ha	148.57	11.06	203.35
8	T_8	Nitrogen 140 kg/ha + Fe 20 kg/ha	151.07	11.33	204.83
9	T_9	Nitrogen 140 kg/ha + Fe 30 kg/ha	154.90	11.73	206.49
10	T_{10}	Farmer's practice (100:60:40)	135.07	10.80	183.77
		SEm (±)	1.37	0.26	0.78
		CD (P 0.05)	*4.06	*0.76	*2.31

Farmer practice - 100 kg N through urea and DAP, 60 kg P2O5 through DAP and 40 kg K2O through MOP, DAP- Di-ammonium phosphate, MOP- Muriate of Potash, *Significant at P < 0.05

Table.2 Effect of nitrogen and iron levels on yield and yield attributing characters of rabi hybrid maize var. 'RHM- 4212' at harvest

S. No	T. No	Treatment	No. of cobs/plant	No. of grains/cob	Test weight (g)	Grain Yield (t/ha)	B:C ratio
1	T_1	Nitrogen 100 kg/ha + Fe 10 kg/ha	1.50	299.08	30.27	4.27	1.68
2	T_2	Nitrogen 100 kg/ha + Fe 20 kg/ha	1.58	296.25	30.47	4.40	1.66
3	T_3	Nitrogen 100 kg/ha + Fe 30 kg/ha	2.00	328.50	30.63	4.60	1.67
4	T_4	Nitrogen 120 kg/ha + Fe 10 kg/ha	1.42	307.50	30.93	5.03	1.97
5	T_5	Nitrogen 120 kg/ha + Fe 20 kg/ha	1.83	302.50	31.10	5.20	1.95
6	T_6	Nitrogen 120 kg/ha + Fe 30 kg/ha	1.83	343.42	31.27	5.43	1.96
7	T_7	Nitrogen 140 kg/ha + Fe 10 kg/ha	1.58	355.08	31.73	5.63	2.18
8	T_8	Nitrogen 140 kg/ha + Fe 20 kg/ha	1.75	374.17	31.80	5.80	2.15
9	T_9	Nitrogen 140 kg/ha + Fe 30 kg/ha	2.00	392.83	31.93	5.97	2.13
10	T_{10}	Farmer's practice (100:60:40)	1.42	303.33	29.37	4.13	1.77
		SEm (±)	0.11	11.77	0.21	0.11	
		CD (P 0.05)	*0.34	*34.98	*0.63	*0.34	

Farmer practice - 100 kg N through urea and DAP, 60 kg P2O5 through DAP and 40 kg K2O through MOP, DAP- Di-ammonium phosphate, MOP- Muriate of Potash, *Significant at P < 0.05

No. of leaves/plant: At harvesting stage maximum number of leaves per plant (11.73) are produced by T_9 (Nitrogen 140 kg/ha and Fe 30 kg/ha). There was no significant difference among the treatments. Promotion effect in application of Nitrogen 140 kg/ha and Fe 30 kg/ha mainly due to N and Zn which helps in the production and expansion of more leaf area which results more assimilates production and also in increase in plant height observed by Asif *et al.,* (2013) Fe deprivation increased the levels of thiol compounds in maize leaves with a concomitant decrease in the activities of enzymes involved in S metabolism, like ATP sulphurylase and OAS sulphydrylase observed by Astolfi *et al*., (2003) Iron deficit will reduce leaves dry weight, leaf area, Iron concentration and chlorophyll observed by Mariotti *et al.,* (1996).

Dry weight (g/plant): At harvest DAS the highest dry weight was observed inT_9(Nitrogen 140 kg/ha + Fe 30 kg/ha) and the lowest was recorded in T_{10}(Farmer's practice (100:60:40)). However, T_8(Nitrogen 140 kg/ha + Fe 20 kg/ha) were found statistically at par toT_9(140 kg/ha + Fe 30 kg/ha). There was significant difference among the treatments. The probable reason for recording maximum test weight with the application of Nitrogen 140 kg/ha + Fe 30 kg/ha. Obtained data show that increasing nitrogen fertilization rates up to 140 Kg N leads to a significant increase in plant height, weight of leaf ear, ear weight, grain weight of ear, 100 grain weight, straw and grain yield of maize as compared with control treatment Observed by the qEl-Douby *et al.*, (2001), N is the motor of plant growth and makes up 1 to 4% of dry matter of the plants. Reported by Taiz and Zeiger (2010) due to using zinc and iron content of grain's carbohydrates, starch, Indol acetic acid, chlorophyll and protein will be increased by which these are effective on grain weight of ear reported by Rajaei and Ziaeian (2009).

Yield and yield attributes

Grain yield (t/ha)

The grain yield recorded at harvest is presented in table 2. The data shows that there was a significant effect of different treatments on the test weight.

The highest grain yield was recorded in the treatment of application of T_9(Nitrogen 140 kg/ha + Fe 30 kg/ha). However, T_7(Nitrogen 140 kg/ha + Fe 10 kg/ha) and T_8 (Nitrogen 140 kg/ha + Fe 20 kg/ha) were found statistically at par to T_9 (Nitrogen 140 kg/ha + Fe 30 kg/ha). There was significant difference among the treatments.

The highest grain yield was resulted due to the application of T_9 (Nitrogen 140 kg/ha + Fe 30 kg/ha). the use of Nitrogen fertilization results in increased grain yield (43-68%) and biomass (25-42%) in maize reported by Ogola *et al.*, (2002) there is a significant increase in grain yield as results of increasing nitrogen levels from 100 to 125kg N reported by El-Bana and Gomaa (2000) the obtained data show that increasing nitrogen fertilization rates up to 140 Kg N led to a significant increase in plant height, weight of leaf ear, ear weight, grain weight of ear, 100 grain weight, straw and grain yield of maize as compared with control treatment Observed by qEl-Douby *et al.*, (2001) The highest grain yield of 7.37 t/ha was recorded with 150 N kg/ha which was statistically at par with that of 125 N kg/ha with a yield of 7.14 t/ha and significantly lowest yield was obtained from 75 N kg/ha in main plot reported by Ankita Begam. (2018) maize grain yield was significantly increasing N rate increased and maximum figure was obtained due to addition of 140 kg N. founded by El-Naggar and Amer (1999) increasing N- rate was accompanied with a reduction in NUE value, science the values were 36.98, 33.12 and 28.41 kg grain/kg N added at 100, 120 and 140 kg N/ha respectively reported by Hanan S. Siam (2008) the yield and yield component of maize were increased by increasing the rate of applied nitrogen, 160Kg N significantly increased ear characters and grain yield of maize reported by Torbert *et al.,* (2001) the micronutrients attributed behaviour the favourable use of zinc and iron increased the amount of grain's protein in wheat reported by Farajzadeh *et al.,* (2009). There is another widely used method to apply Zn and Fe fertilizers which is soil application. It is believed to be an efficient way of correcting symptoms of soil Zn or Fe deficiency, significantly improved grain yield, biomass and harvest index in rice as well as enhancing Zn concentration and N in maize grain Reported by Wang *et al.,* (2012) in case of maize, soil application of Zn and Fe in more doable and effective for enhancing both grain yield and grain nutrient concentration by building up soil available Zn and Fe to requirement of high yield and grain nutrient concentration reported by Liu *et al.,* (2017). Saleem *et al.,* (2016) concluded that maize grain yield and their Zn and Fe content responded positively towards Zn and Fe application applied as soil or foliar application Whereas 30 kg of Zn and Fe/ha gave highest grain yield (7.76 t/ha) which is at par with 7.64 t/ha grain yield from the plots receiving 20 kg of Zn and Fe/ha. Almost similar results with that iron and zinc fertilization is an effective way to increase corn yield, their concentration in maize grain and finally to get better quality corn.

It is concluded that for obtaining highest yield in maize during *rabi* season, the treatment combination T_9 (Nitrogen 140 kg/ha + Fe30 kg/ha) was found to be the best. But I suggest farmer to apply treatment combination of T_7 (Nitrogen 140 kg/ha + Fe10 kg/ha) instead of T_9 (Nitrogen 140 kg/ha + Fe30 kg/ha) to ensure cost of cultivation is minimum. Although the finding is based on one season, further research is needed to confirm the findings and its recommendation.

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