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Response of maize (*Zea mays* L.) genotypes to nitrogen levels during *rabi* under irrigated condition

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Abstract
The field experiment was conducted at the Agricultural Research Station, Siruguppa during *rabi* 2020-21 to study the response of maize (*Zea mays* L.) genotypes to nitrogen levels during *rabi* under irrigated conditions. The experiment consisted of twelve treatment combinations of four genotypes *viz.*, V_1: RCRMH 2, V_2: RCRMH 3, V_3: RCRMH 4 and V_4: NK-6240 and three nitrogen levels, F_1:225 N kg ha^{-1}, F_2: 187.5 N kg ha^{-1} and F_3: 150 N kg ha^{-1} these were replicated thrice in split plot design. The genotype NK-6240 recorded significantly higher number of cobs plant^{-1} (1.38), cob length (17.94 cm), cob girth (17.54), cob weight (289.99 g and 210.64 g cob^{-1} with husk and without husk, respectively), number of grains row^{-1} (30.08), hundred seed weight (30.81 g), grain yield plant^{-1} (164.50 g), shelling percentage (78.03%), grain yield (7659 kg ha^{-1}), stover yield (9449 kg ha^{-1}), harvest index (44.75), gross returns (Rs.114311 ha^{-1}), net returns (Rs. 71801 ha^{-1}) and B:C (2.68) and it was on par with the genotype RCRMH 4. Application of 150% N kg ha^{-1} recorded significantly higher number of cobs plant^{-1} (1.36), cob length (17.76 cm), cob girth (17.26), cob weight (291.41 g and 215.85 g cob^{-1} with husk and without husk, respectively), number of grains row^{-1} (29.97), hundred seed weight (29.42 g), grain yield plant^{-1} (171 g), shelling percentage (79.15%), grain yield (7664 kg ha^{-1}), stover yield (9592 kg ha^{-1}), harvest index (44.38), gross returns (Rs. 114497 ha^{-1}), net returns (Rs. 71503 ha^{-1}) and B:C (2.66) compared to rest of the N levels. Hence, planting of maize genotypes NK-6240 and RCRMH 4 with application of 150% N kg ha^{-1} was found more productive and remunerative in *rabi* under irrigated condition.

Keywords: Genotypes, nitrogen levels, grain and stover yield, gross returns and net returns

Introduction
Maize (*Zea mays* L.) is one of the most versatile emerging crops and its grain today is recognized worldwide as a strategic food and feed crop that provides an enormous amount of protein and energy for humans and livestock. Globally, maize is known as queen of cereals as it has the highest genetic yield potential among the cereals. It is occupying 150 m/ha in about 160 countries possessing wider diversity of soil, climate, biodiversity and management practices that contribute 36% (782 metric tonnes) to the global grain production. Globally it is grown on an area of 192.50 m ha with an annual production of 1, 112 mtata productivity of 5742 kg ha^{-1} (Anon., 2019b) [2]. In India, currently, it is cultivated on an area of 9.38 m ha with a production of 28.75 m t and at a productivity of 3065 kg ha^{-1} (Anon., 2019b) [2]. In Karnataka *rabi* maize is grown in an area of 0.124 m ha with a production of 0.46 mt and productivity of 3710 kg ha^{-1} (Anon., 2019a) [1].

Among the primary nutrients, nitrogen though an expensive input is very important as it is intimately involved in the process of photosynthesis and directly reflected in the total dry matter production and yield. Nitrogen is the most important input for realizing protein yield of any crop as requirement of nitrogen is the highest among all the essential plant nutrients as this nutrient is most limiting under Indian condition. Maize is an exhaustive crop requires a regulated and assured supply of nutrients particularly nitrogen throughout its growing period right from seedling stage to grain filling stage. Its deficiency at any stage of growth, especially at tasseling and Silking stage, may lead to small, shriveled grains and virtual crop failure. Hence, judicious use of nitrogen is pivotal role in crop production as it can alone contributes 45-60% crop yield (Damor *et al.*, 2017) [5]. In view of more favourable growing conditions, response to application of nitrogen and other nutrients is better in *rabi* than *kharif* season.

The losses during *rabi* can be checked effectively through appropriate quantity of nitrogen management. With better response from every unit of fertilizers, which is the major component of cultivation cost, it is possible to reduce the production cost during *rabi*. Hence, the present study was undertaken with an objective to know the response of maize (*Zea mays* L.) genotypes to nitrogen levels during *rabi* under irrigated condition.

Materials and Methods

The field experiment was conducted to study the response of maize (*Zea mays* L.) genotypes to nitrogen levels during *rabi* under irrigated condition" at Agricultural Research Station, Siruguppa, University of Agricultural Sciences, Raichur during *rabi* 2020-21 on clay soil with pH of 8.36, organic carbon content of 0.46% and electrical conductivity of 0.37 dS m^{-1}. The available N, P_2O_5 and K_2O were 215.2, 34.6 and 340.80 kg ha^{-1}, respectively. The experiment consisted of twelve treatment combinations of four genotypes *viz*., V_1: RCRMH 2, V_2: RCRMH 3, V_3: RCRMH 4 and V_4: NK-6240 and three nitrogen levels, F_1: 225 N kg ha^{-1}, F_2: 187.5 N kg ha^{-1} and F_3: 150 N kg ha^{-1} these were replicated thrice in split plot design. The nitrogen application as per treatment *viz*., 100% of N kg ha^{-1}, 125% of N kg ha^{-1} and 150% of N kg ha^{-1} in the form of urea after calculating the proportion of nitrogen supplied through DAP, 75 kg ha^{-1} of phosphorus in the form of DAP and 37.5 kg ha^{-1} of potash in the form of MOP were applied. The cost includes expenditure on seeds, fertilizers, weed management and plant protection chemicals. At maturity, the crop was harvested and plot wise yields were recorded. The data recorded from the experiment during crop growth period was subjected to statistical analysis at 5% probability as described by Gomez and Gomez (1984) [8].

Results and Discussion

Performance of maize genotypes on yield, yield attributing characters and economics

The grain and stover yield of maize were significantly influenced by the genotypes. Significantly higher grain yield (7659 kg ha^{-1}) and stover yield (9449 kg ha^{-1}) was recorded by NK-6240 genotype and it was on par with RCRMH 4 genotype (7218 and 9012 kg ha^{-1}, respectively). Significantly lower grain yield (6026 kg ha^{-1}), stover yield (7841 kg ha^{-1}) and harvest index (44.75) was registered by RCRMH 2 genotype (Table 3). Significantly higher gross returns (Rs. 114311 ha^{-1}), net returns (Rs. 71801 ha^{-1}) and B:C (2.68) was registered by NK-6240 genotype and it was on par with the genotype RCRMH 4 (Table 3). These results are in with findings of Gollar (1996) [7] who compared the performance of two genotypes narrated that Deccan-103 recorded 17% higher yield than G-25 composite.

The grain yield of maize is a function of many yield attributing characters like cob length, cob girth, number of grains per row, grain rows per cob, test weight and cob weight per plant (with and without husk) which were significantly influenced by different genotypes. NK-6240 genotype registered significantly higher number of cobs $plant^{-1}$ (1.38), cob length (17.94 cm), cob girth (17.54) (Table 1), cob weight (289.99 g and 210.64 g cob^{-1} with husk and without husk, respectively), number of grains row^{-1} (30.08), hundred seed weight (30.81 g), grain yield $plant^{-1}$ (164.50 g), shelling percentage (78.03%) and it was on par with RCRMH 4 genotype (Table 2). This might be due to genetic makeup of the plant, its wider adaptability under varied environments, good responsive to high input management and excellent agronomics and consistency, and insect, disease resistance coupled with higher values of yield attributing parameters (Vishuddha, 2015) [15]. Similar results were also reported by Pandu (2019) [10], Sharanabasappa and Basavanneppa, 2019 [13] and Basavanneppa and Kuchanur (2020) [3].

Effect of nitrogen levels on yield, yield attributing characters and economics of maize

Significantly higher grain and stover yield (7664 kg ha^{-1} and 9592 kg ha^{-1}, respectively) were recorded with application of 150% of N kg ha^{-1} with yield advantages to an extent of 33.05% and 10.66% over nitrogen levels of 100% of N kg ha^{-1} and 125% of N kg ha^{-1}, respectively (Table 3). The increased grain yield was due to the application of 150% of N kg ha^{-1} did cause about significant improvement in overall growth of the crop by virtue of increased photosynthetic efficiency. Thus, greater availability of photosynthates, metabolites and nutrients to develop reproductive structures seems to have resulted in increased productive plants, cob girth, cob length (Table 1), cob weight (with and without husk), number of grains per row, hundred seed weight, number of cobs per plant, grain yield per plant and shelling percentage with these fertility levels (Table 2). These results are in cognizance with findings of Bhatt (2012) [4], Mathukia (2014) [9], Vishuddha (2015) [15], Sharanabasappa (2016) [12], Dangariya *et al.* (2017) [6], Rathod *et al.* (2018) [11], Sharanabasappa and Basavanneppa (2019) [13].

The yield attributing characters were significantly influenced by different nitrogen levels. The higher number of cobs $plant^{-1}$ (1.36), cob length (17.76 cm), cob girth (17.26), cob weight (291.41 g and 215.85 g cob^{-1} with husk and without husk, respectively), number of grains row^{-1} (29.97), hundred seed weight (29.42 g), grain yield $plant^{-1}$ (171 g), shelling percentage (79.15%) (Table 1 and Table 2), gross returns (Rs. 114497 ha^{-1}), net returns (Rs.71503 ha^{-1}) and B:C (2.66) were observed with application of 150% of N and lower values with the application of 100% of N (Table 3). This was due to maintaining congenial nutritional environment of plant system on account of their greater availability from soil media that might have resulted in greater synthesis of amino acids, proteins and growth promoting substances, which seem to have enhanced the meristematic activity and increased cell division and their elongation. In the present study, application of 150% of N might have increased interception, absorption and utilization of radiant energy which in turn increased photosynthesis and thereby increased yield components *viz.*, cob length, cob girth, cob weight (with and without husk), number of grains per row, hundred seed weight, number of cobs per plant, grain yield per plant and shelling percentage. The findings are in conformity with the findings of Mathukia *et al.* (2014) [9], Dangariya *et al.* (2017) [6], Singh *et al.* (2017) [14] and Rathod *et al.* (2018) [11].

Table 1: Yield components of maize as influenced by genotypes and nitrogen levels in *rabi* under irrigated condition

Treatments	Number of cobs plant^{-1}	Cob length (cm)	Cob girth (cm)	No of grains row^{-1}	Hundred seed weight (g)
Genotypes (V)					
V_1 –RCRMH 2	1.20	15.86	15.45	28.66	23.87
V_2 –RCRMH 3	1.24	15.85	15.55	29.16	27.92
V_3–RCRMH 4	1.30	16.90	16.24	29.83	29.29
V_4 –NK-6240	1.38	17.94	17.54	30.08	30.81
S.Em. ±	0.04	0.44	0.41	0.09	0.98
C.D (P=0.05)	NS	1.57	1.45	0.34	3.48
Nitrogen levels (F)					
F_1- 100% N (150 N kg ha^{-1})	1.18	15.62	15.33	28.68	27.21
F_2 - 125% N (187.5 N kg ha^{-1})	1.30	16.54	16.00	29.64	27.29
F_3 - 150% N (150% of N^{-1})	1.36	17.76	17.26	29.97	29.42
S.Em. ±	0.05	0.45	0.40	0.07	0.53
C.D (P=0.05)	NS	1.21	1.23	0.21	1.61
Interaction					
F at same level of V					
S.Em. ±	0.08	0.77	0.71	0.16	1.71
C.D (P=0.05)	NS	NS	NS	NS	NS
V at same or different levels of F					
S.Em. ±	0.10	0.86	0.78	0.15	1.31
C.D (P=0.05)	NS	NS	NS	NS	NS

RDF:150:75:37.5 kg NPK ha^{-1} P and K as per the recommendation to all the treatment

Table 2: Cob weight with husk, cob weight without husk, grain yield per plant and shelling percentage of maize as influenced by genotypes and nitrogen levels in *rabi* under irrigated condition

Treatments	Cob weight with husk plant^{-1} (g)	Cob weight without husk plant^{-1} (g)	Grain yield plant^{-1} (g)	Shelling percentage (%)
Genotypes (V)				
V_1 –RCRMH 2	257.60	191.76	123.56	64.08
V_2 –RCRMH 3	267.28	195.95	134.87	68.80
V_3–RCRMH 4	278.68	206.21	151.42	72.73
V_4 –NK-6240	289.99	210.64	164.50	78.03
S.Em. ±	5.77	3.81	4.46	2.38
C.D (P=0.05)	20.73	13.45	15.71	8.41
Nitrogen levels (F)				
F_1- 100% N (150 N kg ha^{-1})	252.29	187.57	116.24	62.03
F_2 - 125% N (187.5 N kg ha^{-1})	276.46	200.01	143.52	71.54
F_3 - 150% N (150 N kg ha^{-1})	291.41	215.85	171.00	79.15
S.Em. ±	4.05	3.13	3.58	1.81
C.D (P=0.05)	12.24	9.39	10.82	5.48
Interaction				
F at same level of V				
S.Em. ±	10.70	6.60	7.71	4.13
C.D (P=0.05)	NS	NS	NS	NS
V at same or different levels of F				
S.Em. ±	8.70	6.30	7.35	3.80
C.D (P=0.05)	NS	NS	NS	NS

RDF150:75:37.5 kg NPK ha^{-1} P and K as per the recommendation to all the treatment

Table 3: Grain yield, stover yield, harvest index, Gross returns, Net returns and B:C of maize as influenced by genotypes and nitrogen levels in *rabi* under irrigated condition.

Treatments	Grain yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Harvest index (%)	Gross Returns (Rs. ha^{-1})	Net returns (Rs. ha^{-1})	B:C
Genotypes (V)						
V_1 –RCRMH 2	6026	7841	43.49	90247	48554	2.16
V_2 –RCRMH 3	6230	8089	43.52	93288	51493	2.23
V_3–RCRMH 4	7218	9012	44.43	107813	65524	2.54
V_4 –NK-6240	7659	9449	44.75	114311	71801	2.68
S.Em. ±	187	338	0.89	2698	2698	0.06
C.D (P=0.05)	659	1193	NS	9517	9517	0.22
Nitrogen levels (F)						
F_1- 100% N (150 N kg ha^{-1})	5760	7453	43.56	86228	45149	2.10
F_2 - 125% N (187.5 N kg ha^{-1})	6926	8747	44.19	103519	61376	2.45
F_3 - 150% N (150% of N^{-1})	7664	9592	44.38	114497	71503	2.66
S.Em. ±	158	207	0.59	2277	2277	0.05

C.D (P=0.05)	477	625	NS	6886	6886	0.16
Interaction						
F at same level of V						
S.Em. ±	324	586	1.54	4672	4672	0.10
C.D (P=0.05)	NS	NS	NS	NS	NS	NS
V at same or different levels of F						
S.Em. ±	318	478	1.31	4594	4594	0.10
C.D (P=0.05)	NS	NS	NS	NS	NS	NS

RDF: 150:75:37.5 kg NPK ha^{-1}, P&K as per the recommendation to all the treatment

Conclusion

Performance of NK-6240 and RCRMH 4 genotypes were found better as compared to RCRMH 2 and RCRMH 3 with respect to yield, yield parameters and economics with the application of 150% of nitrogen produced higher grain yield over 100% of nitrogen and 125% of nitrogen. Hence**,** planting of maize genotypes NK-6240 and RCRMH 4 with application of 150% of nitrogen was found productive and remunerative.

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