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Impact of Date of Sowing and Nutrient Management on Yield and Nutrient Uptake of Bread Wheat (*Triticum aestivum* L.) Genotypes under Late Sown Irrigated Condition

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A B S T R A C T

Field experiment was conducted at Agricultural Research Station, Almel to study the Impact of date of sowing and nutrient management on yield and nutrient uptake of bread wheat (*Triticum aestivum* L.) genotypes under late sown irrigated condition during *rabi* 2014-15. The experiment was laid out in split-split plot design with three replications. There were three genotypes (HD-3090, NIAW-34 and DWR-195) in main plot treatments, two sowing date (December 15th and December 30th) in sub plot treatment and two fertilizer levels (100:75:50 and 125:93.75:62.5 kg N, P_2O_5 and K_2O ha^{-1}) in sub-sub plot treatments. The wheat genotype HD-3090 produced significantly higher grain yield (3628 kg ha^{-1}), straw yield (5152 kg ha^{-1}) and harvest index (40.88%) compared to the genotype NIAW-34 (2710, 4142 kg ha^{-1} and 39.53%, respectively). Significantly higher yield was attributed to significantly higher nitrogen, phosphorus and potassium uptake at harvest (77.9, 17.4 and 91.9 kg ha^{-1}, respectively). The crop sown on December 15th recorded significantly higher grain yield (3260 kg ha^{-1}), straw yield (4810 kg ha^{-1}) and nitrogen, phosphorus and potassium uptake at harvest (72.9, 15.7 and 85.5 kg ha^{-1}, respectively) compared to December 30th sowing. Fertilizer level of 125:93.75:62.5 kg N, P_2O_5 and K_2O ha^{-1} recorded significantly higher grain yield (3111 kg ha^{-1}), straw yield (4713 kg ha^{-1}) and nitrogen, phosphorus and potassium uptake at harvest (74.7, 15.9 and 86.5 kg ha^{-1}, respectively) compared to 125:93.75:62.5 kg N, P_2O_5 and K_2O ha^{-1}. Higher interaction effect of wheat genotype HD 3090 sown on December 15th at fertilizer level of 125:93.75:62.5 kg N, P_2O_5 and K_2O ha^{-1} recorded significantly higher grain yield (3983 kg ha^{-1}), straw yield (5519 kg ha^{-1}) and harvest index (41.84%) with higher nutrient uptake.

Keywords

Bread wheat, sowing date, fertilizer level, Nutrient uptake

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Introduction

Wheat (*Triticum aestivum* L.), India occupies first place with regard to area and second in production in the world. Importance of wheat in Indian agriculture is second only to rice. It is grown over an area of 29.8 m ha with total annual production of 95 m t and productivity of 3.2 t ha^{-1} (Anon., 2014). In the Indian sub continent, is an important food grain providing nourishment nearly to 35 per cent people of the world. Wheat belongs to family

Poaceae and is one of the leading cereals of many countries of the world. The states of Uttar Pradesh, Punjab and Haryana are the major wheat producers accounting for nearly 70 per cent of the total wheat produced in the country. Uttar Pradesh is the leading producer (25.03 m t) followed by Punjab and Haryana, while Punjab ranks first in productivity with 4207 kg ha^{-1} (Anon., 2014). In Karnataka area under wheat is 0.26 m ha with production of 0.28 mt and productivity of 1094 kg ha^{-1} (www.ksda.nic.in, 2013-14). Karnataka is unique in cultivation of three species, namely, *Triticum aestivum* (bread wheat), *Triticum durum* (durum, macaroni or soji wheat) and *Triticum dicoccum* (dicoccum or emmer wheat). Major wheat growing area is under rainfed condition. Productivity is very low compared to national average, mainly because of non availability of longer cool growing period due to delayed commencement of lower air temperature during early stages and early commencement of higher temperature during its reproductive growth stages. As environmental condition in the vegetative phase determines the plant morphology and time of earing, dates of sowing of wheat crop become important for the final yield. Wheat is also highly responsive to nitrogen levels in the soil and therefore applying adequate doses through fertilizers and organic manure is vital for realizing optimum yield.

The combined application of N, P_2O_5 and K_2O fertilizers exhibited highest yield of wheat (30.97 q ha^{-1}) with the highest uptake of N (64.4 kg ha^{-1}), P_2O_5 (9.69 kg ha^{-1}) and K_2O (248.30 kg ha^{-1}), which was closely followed by the treatment where in N, K and Zn were applied together. However, the results further indicated that the application of FYM exhibited a higher grain yield of wheat (48.60 %) over control suggesting a greater role of organic manures especially FYM towards increasing the yield of wheat (Maiti and Sarkar, 2003).

It is also the predominant *rabi* season crop in Northern Dry Zone of Karnataka under irrigated conditions. Being a thermosensitive crop, sowing time plays a vital role in the growth, yield and nutrient uptake of wheat and therefore must be considered as a non-monetary input. Wheat being a heavy feeder of nutrients, heavy dose of fertilizers is a pre-requisite for higher yield. Not much work has been done on the date of sowing and nutrient management on yield and nutrient uptake of bread wheat in the Zone 3 of Karnataka. Hence to study the individual as well as interaction effects of these two factors the experiment was planned.

Materials and Methods

A field experiment on "Impact of date of sowing and nutrient management on yield and nutrient uptake of bread wheat (*Triticum aestivum* L.) genotypes under late sown irrigated condition" was conducted during *rabi* 2014-15 at Agricultural Research Station, Almel which is situated in Northern dry zone (Zone 3) of Karnataka state at (16^0 49' North latitude and 75^0 43' and East longitude at an altitude of 593.8 m above the mean sea level), University of Agricultural Sciences, Dharwad (Karnataka). The experiment was laid out in split-split plot design with three replications. There were three genotypes (HD-3090, NIAW-34 and DWR-195) in main plot treatments, two sowing date (December 15th and December 30th) in sub plot treatment and two fertilizer levels (100:75:50 and 125:93.75:62.5 kg N, P_2O_5 and K2O ha^{-1}) in sub-sub plot treatments. The soil of the experimental site was *Vertisol* (medium deep black soil). At the time of sowing half dose of nitrogen and full dose of phosphorus and potassium were applied as basal dose. Basal application was done in lines 5.0 cm by the side of the seed rows. The remaining 50 per cent nitrogen was top dressed at 30 days after sowing. The seeds were sown @ 150 kg ha^{-1} at 23 cm row spacing by opening furrows with the help of marker. The seeds were treated with *Azospirillum* @ 2.0 kg per ha seed rate before sowing. Later the seeds were covered manually.

The crop was sown as per date of sowing *i.e.*, on 15th and 30th December, 2014. All the cultural methods were adopted as per the state recommended package of practices. Irrigations were given as per the crop requirement.

The crop was harvested as and when the three genotypes matured at different time. Earliest matured variety was HD 3090, followed by DWR 195 and lastly, the variety NIWA genotypes matured during the month of April 2015. Five random plants were selected from each plot, excluding the border row, for taking growth observations.

The representative dry samples of Stover and grains were analysed for ascertaining the nutrient (N, P and K) content. The N content was analysed by Micro Kjeldahl method expressed in percentage (Jackson, 1967), P content was analyzed by Vanadomolybdo phosphoric acid yellow-colour methods (Jackson, 1967) and K content was estimated by using flame photometer as described by Jackson (1967) respectively.

The data pertaining to each of the characters of the experimental crop were tabulated and finally analysed statistically by applying the standard technique to draw a valid conclusion. The experimental data were statistically analyzed using MSTAT-C programme. The level of significance used in F test was P=0.05. The mean values of interaction treatment were subjected to Duncan's Multiple Range Test (DMRT) using the corresponding error mean sum of squares and degrees of freedom values.

Results and Discussion

Response of bread wheat genotypes, date of sowing, fertilizer levels and their interaction on grain yield, straw yield and harvest index

The bread wheat genotype HD 3090 recorded significantly higher grain and straw yield (3628 and 5152 kg ha-1, respectively) compared to other genotypes. The yield increase was 25.27 and 19.60 per cent, respectively compared to NIAW 34 and DWR 195, respectively. And also HD 3090 genotype recorded significantly higher harvest index (40.88%). Significantly higher yield of genotype HD 3090 could be attributed to its thermo-tolerant nature and significantly higher performance of yield. Similar findings of higher yield in wheat genotype were reported by Patil (1996), Wang *et al.*, (1998) and Patel (1999). The significantly least grain and straw yield recorded with genotype NIAW-34 (2710 and 4142 kg ha^{-1}, respectively).

The crop sown on December 15th recorded significantly higher grain and straw yield (3260 and 4810 kg ha^{-1}, respectively) compared to December 30th sowing. The yield increase with early sowing was 13.68 and 9.45 per cent, respectively over December 30th sowing. And also crop sown on December 15th recorded significantly higher harvest index (40%) compared to December 30th sowing. This was due to significantly higher yield.

The significantly least grain and straw yield recorded with crop sown on December 30th (2814 and 4355 kg ha^{-1}, respectively) and also harvest index recorded significantly lower (39.17%) was due to significantly lower yield. Similar results were reported by Ansary *et al.*, (1989), Sial *et al.*, (2005).

Fertilizer level of 125:93.75:62.50 kg N, P_2O_5 and K_2O ha^{-1} recorded significantly higher grain and straw yield (3111and 4713 kg ha^{-1}, respectively) compared to RDF. The yield increase was 4.75 and 5.53 per cent, respectively compared to RDF.

Fertilizer levels did not influence significantly the harvest index. This was due to significantly higher yield. These findings are in agreement with Gami *et al.,* (1986) and Yadav *et al.,* (2014). The significantly least grain and straw yield recorded with fertilizer level of 100:75:50 kg N, P_2O_5 and K_2O ha^{-1} (F_1, 2963 and 4452 kg ha^{-1}, respectively) was due to significantly lower yield.

The interaction of genotype HD 3090 sown on December 15th at fertilizer level of 125:93.75:62.5 kg N, P_2O_5 and K_2O ha^{-1} recorded significantly higher grain yield (3983 kg ha^{-1}), straw yield (5519 kg ha^{-1}) and harvest index (41.84%). The grain and straw yield increase was 38.08 and 34.57 per cent, respectively compared to 100:75:50 kg N, P_2O_5 and K_2O ha^{-1}. This was mainly due to significantly higher yield. These results are in agreement with Bharti *et al., (*1987).

The next best significantly higher interaction for grain yield (3851 kg ha^{-1}), straw yield (5187 kg ha^{-1}) and harvest index (41.11%) was recorded with genotype HD 3090 sown on December 15th at fertilizer level of 100:75:50 kg N, P_2O_5 and K_2O ha^{-1}. This was mainly due to significantly higher performance of yield.

The interaction genotype NIAW 34 sown on December 30th at fertilizer level of 100:75:50 N, P_2O_5 and K_2O kg ha^{-1} recorded significantly lower grain yield (2466 kg ha^{-1}) and straw yield (3611 kg ha^{-1}). This was due to significantly lower yield with this interaction and the significantly least individual effect of genotype, date of sowing and fertilizer level. Similar results were also reported by Shah *et al.,* (2006) and Tahir *et al.*, (2009).

Response of bread wheat genotypes, date of sowing, fertilizer levels and their interaction on nutrient uptake (N, P and K)

Increased availability of nutrients due to build up of soil microflora which consequently increases the nutrient release from soil and enzymatic activity helps in increased uptake of nutrients (Boomathi *et al.,* 2005). Higher grain yield was attributed to the higher uptake of applied nutrients by the crop.

Among the genotypes, HD 3090 recorded significantly higher uptake of nitrogen, phosphorus and potassium at 60 DAS (61.5, 10.3 and 74.4 kg N, P_2O_5 and K_2O ha^{-1}, respectively) and at (77.9, 17.4 and 91.9 kg N, P_2O_5 and K_2O ha^{-1}, respectively) compared to DWR-195. This was due to significantly higher performance of nutrient uptake.

Nutrient uptake at 60 DAS was significantly higher with crop sown on December 15th (57.8, 8.7 and 69.6 kg N, P_2O_5 and K_2O ha^{-1}, respectively) compared to December 30th sowing. This was due to prolonged winter period available to early sown crop with better growth and yield. At harvest, plant nutrient uptake did not differ significantly.

The fertilizer level of 125:93.75:62.5 kg N, P_2O_5 and K_2O ha^{-1}, respectively (125% RDF) recorded significantly higher nutrient uptake at 60 DAS (F_2, 57.6, 8.7 and 69.3, kg N, P_2O_5 and K_2O ha^{-1}, respectively) and at harvest (F_2, 74.7, 15.9 and 86.5, kg N, P_2O_5 and K_2O ha^{-1}, respectively) compared to lower fertilizer level (100% RDF). This was due to higher response of the crop to higher nutrition leading to higher yield. These results are in conformity with the finding of Pradhan *et al., (*1990) and Bhogal *et al.,* (1996) (Table 1).

Table.1 Impact of date of sowing and nutrient management on grain yield, straw yield, harvest index and nutrient uptake of bread wheat genotypes under late sown irrigated condition

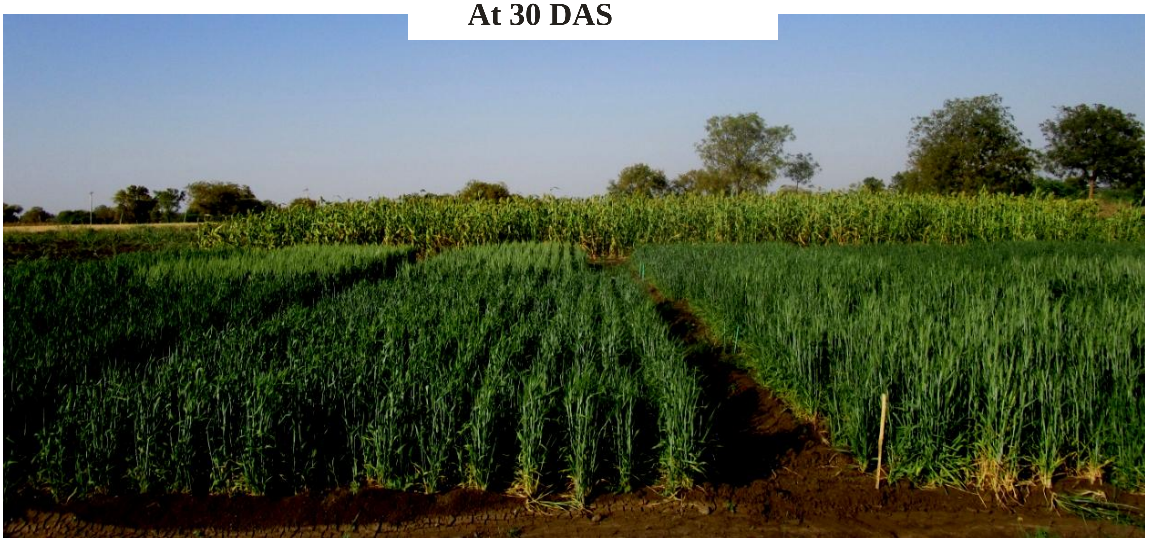
Treatment	Available nutrient status in soil after harvest (kg ha^{-1})			Total nutrient uptake at 60 DAS (kg ha^{-1})			Total nutrient uptake at harvest (kg ha^{-1})			Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest index (%)
	N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O			
Genotypes (G)												
G_1	248.3^{c}	26.1^{c}	353.7^{b}	61.5^{a}	10.3^{a}	74.4^{a}	77.9^{a}	17.4^{a}	91.9^{a}	3628^{a}	5152^{a}	40.88^{a}
G_2	262.2^{a}	28.5^{a}	366.9^{a}	53.2^{b}	7.2^{b}	62.7^{c}	65.9^{c}	13.3^{c}	77.0^{c}	2710^{b}	4142^{c}	39.53^{b}
G_3	253.4^{b}	27.2^{b}	357.5^{ab}	56.7^{ab}	7.8^{b}	68.4^{b}	72.9^{b}	14.8^{b}	83.7^{b}	2772^{b}	4454^{b}	38.32^{b}
S.Em$\pm$	1.0	0.4	2.8	1.4	0.3	0.5	0.2	0.3	1.2	74	77	0.28
Date of sowing (D)												
D_1	254.0^{a}	27.5^{a}	360.3^{a}	57.8^{a}	8.7^{a}	69.6^{a}	72.9^{a}	15.7^{a}	85.5^{a}	3260^{a}	4810^{a}	40.0^{a}
D_2	255.2^{a}	27.0^{a}	358.4^{a}	56.6^{b}	8.2^{b}	67.4^{b}	71.4^{a}	14.7^{a}	82.8^{b}	2814^{b}	4355^{b}	39.17^{b}
S.Em. ±	0.9	0.4	1.6	0.2	0.1	0.4	0.6	0.5	0.5	34	41	0.25
Fertilizer levels (F)												
F_1	253.0^{b}	26.4^{b}	357.6^{b}	56.6^{b}	8.2^{b}	67.7^{b}	69.8^{b}	14.5^{b}	81.9^{b}	2963^{b}	4452^{b}	39.6^{a}
F_2	256.3^{a}	28.2^{a}	361.1^{a}	57.6^{a}	8.7^{a}	69.3^{a}	74.7^{a}	15.9^{a}	86.5^{a}	3111^{a}	4713^{a}	39.6^{a}
S.Em$\pm$	0.9	0.3	0.8	0.2	0.1	0.3	0.5	0.1	0.7	37	16	0.22
Interaction (GxDxF)												
$G_1D_1F_1$	248.4^{cd}	25.5^{de}	352.2^{e}	61.0^{b}	10.8^{b}	74.7^{a}	75.6^{b}	17.6^{b}	91.4^{ab}	3851^{a}	5187^{b}	41.11^{a}
$G_1D_1F_2$	251.7^{cd}	26.9^{b-d}	355.9^{c-e}	63.2^{a}	12.2^{a}	76.0^{a}	82.0^{a}	19.3^{a}	96.6^{a}	3983^{a}	5519^{a}	41.84^{a}
$G_1D_2F_1$	244.7^{d}	24.6^{e}	351.6^{e}	60.3^{b}	8.7^{d}	72.1^{b}	75.0^{b}	15.7^{c}	87.5^{bc}	3290^{cd}	4911^{c}	40.10^{ab}
$G_1D_2F_2$	248.5^{cd}	27.3^{b-d}	355.0^{c-e}	61.5^{b}	9.4^{c}	74.9^{a}	78.8^{ab}	17.3^{b}	92.1^{ab}	3390^{bc}	4991^{c}	40.44^{ab}
$G_2D_1F_1$	260.1^{ab}	28.1^{a-c}	366.5^{a}	54.1^{de}	7.5^{ef}	63.3^{ef}	65.1^{de}	12.9^{gh}	75.7^{fg}	2793^{f}	4337^{f}	39.18^{bc}
$G_2D_1F_2$	263.2^{a}	29.9^{a}	369.6^{a}	54.3^{de}	7.7^{ef}	63.9^{ef}	69.2^{c}	14.4^{d-f}	80.2^{d-f}	3079de	4592de	40.17^{ab}
$G_2D_2F_1$	261.0^{ab}	26.9^{b-d}	364.4^{ab}	51.3^{f}	6.6^{g}	60.7^{g}	62.2^{e}	12.3^{h}	73.8^{g}	2466^{g}	3611^{h}	40.50^{ab}
$G_2D_2F_2$	264.3^{a}	28.9^{ab}	367.0^{a}	53.1^{e}	7.2^{fg}	62.9^{fg}	67.2^{cd}	13.7^{fg}	78.2^{e-g}	2505^{g}	4026^{g}	38.28^{c}
$G_3D_1F_1$	252.2^{c}	27.0^{b-d}	357.6^{c-e}	57.7^{c}	8.0^{de}	69.6^{bc}	70.7^{c}	14.4^{d-f}	82.4^{c-e}	2888^{ef}	4535^{e}	38.90^{bc}
$G_3D_1F_2$	255.7^{bc}	28.4^{ab}	360.1^{bc}	58.3^{c}	8.1^{de}	70.0^{bc}	75.3^{b}	15.4^{cd}	87.0^{bc}	2965^{ef}	4690^{d}	38.73^{bc}
$G_3D_2F_1$	251.4^{cd}	25.9^{c-e}	353.1^{de}	55.2^{d}	7.5^{ef}	65.9^{de}	69.9^{c}	14.1^{ef}	80.4^{d-f}	2489^{g}	4129^{g}	37.60^{c}
$G_3D_2F_2$	254.3^{cd}	27.5^{b-d}	359.2^{b-d}	55.5^{d}	7.6^{ef}	68.0^{cd}	75.5^{b}	15.2^{c-e}	85.1^{cd}	2746^{f}	4463^{e}	38.07^{c}
S.Em. ±	2.1	0.7	2.0	0.5	0.2	0.8	1.2	0.4	1.7	89	40	0.53

Means followed by the same lower case letter(s) in a column do not differ significantly by DMRT (P = 0.05).

G_1: H D-3090
G_2: NIAW-34
G_3: DWR-195

D_1: 15-12-2014 : 100:75:50 kg ha^{-1} N, P_2O_5 and K_2O (100% RDF)
D_2: 30-12-2014 : 125:93.75:62.5 kg ha^{-1} N, P_2O_5 and K_2O (125%RDF)

At 30 DAS



At 60 DAS

At harvest

General view of the experiment plot

The interaction $G_1D_1F_2$ *i.e.* genotype HD 3090 sown on December 15th at fertilizer level of 125:93.75:62.5 kg N, P_2O_5 and K_2O ha^{-1} recorded significantly higher total nutrient uptake by the crop at 60 DAS (63.2, 12.2 and 76.0 kg N, P_2O_5 and K_2O ha^{-1}, respectively) and at harvest (82.0, 19.3 and 96.6 kg N, P_2O_5 and K_2O ha^{-1}, respectively). This was due to significantly higher performance of nutrient uptake obtained with higher fertilizer level. Next best interaction was $G_1D_1F_1$ *i.e.* genotype HD 3090 sown on December 15th at fertilizer level of 100:75:50 kg N, P_2O_5 and K_2O ha^{-1}. Significantly least nutrient uptake was with interaction $G_2D_2F_1$ *i.e* genotype NIAW 34 sown on December 30th at fertilizer level of 100:75:50 kg N, P_2O_5 and K_2O ha^{-1}.

Available nitrogen, phosphorus and potassium in soil after harvest

Significantly higher available nutrient status in the soil after harvest was recorded with the genotypes, NIAW-34 (262.2, 28.5 and 366.9 kg N, P_2O_5 and K_2O ha^{-1}, respectively) compared to genotype DWR-195 (253.4, 27.2 and 357.5 kg N, P_2O_5 and K_2O ha^{-1}, respectively). This was due to lower response of genotype NIAW-34 to applied nutrients. The results are in line with the findings of the Babhulkar *et al.,* (2000). This was no significant effect on available soil nutrient status in the date of sowing. The fertilizer level of 125:93.75:62.5 kg N, P_2O_5 and K_2O ha^{-1} recorded significantly higher available nitrogen, phosphorus and potassium in the soil after harvest of the crop (F_2, 256.3, 28.2 and 361.1 kg N, P_2O_5 and K_2O ha^{-1}, respectively) compared to the 100: 75:50 kg N, P_2O_5 and K_2O ha^{-1} (F_1, 253, 26.4 and 357.6 kg N, P_2O_5 and K_2O ha^{-1}, respectively). These finding are in agreement with Pradhan *et al.,* *(*1990). The interaction $G_2D_1F_2$ *i.e.* genotype NIAW-34 sown on December 15th at fertilizer level of 125:93.75:62.5 kg N, P_2O_5 and K_2O ha^{-1} recorded significantly higher available nitrogen, phosphorus and potassium (263.2, 29.9 and 369.6 kg N, P_2O_5 and K_2O ha^{-1}, respectively) in the soil. This was due to lower response of genotype NIAW-34 to applied nutrients. Significantly least available nitrogen, phosphorus and potassium in soil was recorded with interaction $G_1D_2F_1$ *i.e.* genotype HD-3090 sown on December 30th at fertilizer level of 100:75:50 kg N, P_2O_5 and K_2O ha^{-1} (244.7, 24.6 and 351.6 kg N, P_2O_5 and K_2O ha^{-1}, respectively). This might be due higher response of genotype HD-3090 to applied nutrients.

In conclusion, the wheat genotype HD 3090 sown on December 15th at fertilizer level of 125:93.75:62.5 kg N, P_2O_5 and K_2O ha^{-1} recorded significantly higher grain yield (3983 kg ha^{-1}) with better nutrient uptake in Northern dry zone of Karnataka during late *rabi* irrigated situation.

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