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Impact of various planting dates and suitable nutrient management practices for (*Triticum aestivum* L.) enhanced wheat productivity

Dhiman Mukherjee*, Bikas Mandal, Anirban Maji, and Benukar Biswas

Directorate of Research, Bidhan Chandra Krishi Viswavidyalaya, Kalyani, West Bengal, India

*Corresponding author: dhiman_mukherjee@yahoo.co.in

ABSTRACT

A field experiment was carried out in alluvial agro-climate of zone of West Bengal during *rabi*, 2015-16 and 2016-17 under the aegis of Bidhan Chandra Krishi Viswavidyalaya at AB block farm, Kalyani. The experimental work was conducted in split-plot design with three replications. Four different date of sowing viz. 1st November, 15th November, 30th November and 15th December were randomly allotted to main-plots, while seven different nutrient management aspect mainly control, 50% RDF, 75% RDF, RDF, 50% RDF + FYM (@10 t/ha), 75% RDF + FYM(@10 t/ha) and RDF + FYM(@10 t/ha) were allocated randomly to sub-plots. More number of grain/spike found with the early date of planting (1st November) and was at par with the 15th November, and appreciably better to other main plots treatments. Amid a range of subplot treatments, highest grain/spike registered with the RDF and was at par with the RDF + FYM (@10 t/ha) and 75% RDF + FYM (@10 t/ha). Highest grain yield registered with the 15th November (37.01 q/ha) sowing, and was at par with the early sowing i.e. 1st November (35.07 q/ha). These treatment increases 72.25 and 61.91 % more grain yield over the extreme late sowing condition i.e. 15th December. Further, 75% RDF + FYM (@10 t/ha) gave more economic yield (37.47 q/ha), and was at par with the RDF + FYM (@10 t/ha), RDF and 50% RDF + FYM (@10 t/ha). More straw yield observed with the 15th November sowing, and was considerably superior to other main plot assignment. Amongst various nutrient management, maximum straw yield found with the 75% RDF + FYM (@10 t/ha), and was at par with all other treatments except control and 50 and 75% RDF. The 15th November sowing, gave more biological yield of wheat crop and drastically better to other main plots treatments. Moreover, with various subplot treatments, better this parameter found with the 75% RDF + FYM (@10 t/ha) and was at par with all other treatments, except control and 50 and 75% RDF application. Maximum, NPK uptake observed with early date of sowing i.e. 15th November compared to extreme late sowing condition i.e. 15th December. More primary nutrient removal observed with the 75% RDF + FYM (@10 t/ha) and was at par with RDF + FYM (@10 t/ha) and notably better to other subplot treatments. Amongst various nutrient management practices, more nutrient uptake found with the 75% RDF + FYM (@10 t/ha) and was at par with the full dose of RDF + FYM (@10 t/ha). Economics revealed that, more net return observed in 15th November planting (₹ 40, 453), with highest benefit cost ratio (2.04), and was followed by 1st November sowing. Amongst various nutrient management, highest net return (₹ 40,987) and benefit: cost ratio (2.13) observed with 75% RDF + FYM (@10 t/ha) and was followed by 50% RDF + FYM (@10 t/ha).

Keywords: Nutrient management, productivity, sowing, wheat, yield

Wheat (*Triticum aestivum* L. emend. Fiori & Paol.) is very important and remunerative rabi crop of North Eastern India. It is the second most important cereal crop after rice, grown undere diverse agro-climatic condition on 28 m ha area in India with a production of 92 million ton (4th advance estimate). Wheat is an exhaustive crop of soil nutrients. The deteriorating soil health, declining soil organic matter and increase micronutrient deficiencies has put a big question mark on the sustainability of wheat production. Such kind of problem not only associated with wheat but also other major crop too. World agriculture has been facing a daunting task of producing sufficient food to meet its growing

demand posed by population growth, diet preferences, climatic vulnerability, farmland degradation and growing competition for water and energy (Sharma *et al*., 2013). Among the various factors influencing wheat productivity, optimum time of sowing, better nutrient availability, weed management and suitable cultivars are of supreme importance.

After introduction of high yielding varieties wheat became an important crop in West Bengal. Generally the sowing of wheat gets delayed in the Gangetic plains of this state due to delay in harvesting of *kharif* rice. Even after harvesting of paddy, the soil gets saturated with moisture due to receipt of late monsoon rainfall in high intensity and the farmers of this region have to wait for another 15-20 days so that the soil moisture recedes to optimum one. This delay sowing is burning problem in eastern part of India, due to late harvesting of paddy. By knowing, optimum time of sowing one can fetch good economic return (Mukherjee, 2012). Further, supply of nutrient play important role in improvement of wheat productivity. Today most of our soils are deficient of various micro and macro elements, and this mainly due to inappropriate use of synthetic fertilizer. Use of organic source is very limited and this also leads to deficiency of various micro or trace element, which are very essential for plant metabolism. Use of integrated nutrient management technology or combined use of various sources of nutrients could help to mitigate the problem to some extent. This kind of nutrient supply enhances both uptake of nutrient by wheat crop and availability of soil nutrients during growing season of crops. Such a system of nutrient management using all available sources to meet the crop needs in an integrated manner under different date of sowing was the focal attention under present investigation.

MATERIALS AND METHODS

The field experiment was conducted at District Seed Farm (AB Block), Kalyani under Bidhan Chandra Krishi Viswavidyalaya during winter season of 2015-16 and 2016-17 in upland situation. The farm is situated at approximately 22° 56′ N latitude and 88° 32′ E longitude with an average altitude of 9.75 m above mean sea level (MSL). The soil of the experimental field was loamy in texture with pH 7.1 (1.2.5 soil to water), organic carbon 0.44%, available nitrogen 246.98 kg, available phosphorus 21.44 and available potassium 236.66 kg/ha, at the start of experiment in 0 to 30 cm soil layer (pooled basis of two years). The experimental work was conducted in split-plot design with three replications. Four different date of sowing viz. 1st November, 15th November, 30th November and 15th December were randomly allotted to main-plots, while seven different nutrient management aspect mainly control, 50% RDF, 75% RDF, RDF, 50% RDF + FYM (@10 t/ha), 75% RDF + FYM(@10 t/ha) and RDF + FYM(@10 t/ha) were allocated randomly to sub-plots. The gross size of the plots was 2.07 m x 8 m or 16.56 sq. m (9 rows at 23 cm spacing). Recommended dose of fertilizer (RDF) for this new alluvial zone was 150 kg N, 60 kg P_2O_5 and 40 kg K_2O per hectare. One third of N, full P_2O_5 and K_2O were applied as basal and remaining dose of N was top-dressed in two equal splits at 21 (CRI stage) and 42 (maximum tillering stage) days after sowing. A seed rate of 100 kg/ha was used. Wheat cultivar HD 2967 was used for this experiment. Other management practices were adopted as per recommendations. The growth and yield parameters as well as yield were recorded at harvest and production economics were calculated based on prevailing market price of inputs like seeds, fertilizers, etc and sale price of wheat grain. The nutrient uptake by the crop was obtained as product of nutrient concentration and yield. The crop was harvested as per maturity of the crops. Crop sample were analyzed for uptake of nitrogen, phosphorous and potash as per standard laboratory procedure (Jackson, 1973). The experimental data were analyzed statistically by applying the technique of analysis of variance (ANOVA) prescribed for the design to test the significance of overall difference among treatments by the F test and conclusions were drawn at 5 % probability level (Gomez and Gomez, 1995). Benefit: cost ratio (B: C) was obtained by dividing the gross income with cost of cultivation. The effect of treatments was evaluated on pooled analysis basis on yield attributes and yields.

RESULTS AND DISCUSSION

Growth parameter

The plant height of wheat increased significantly with early date of sowing. Maximum plant height

registered with 1st November and was notably superior to other main plot treatments (Table 1). With various subplot treatments, more plant height found with the RDF + FYM(@10 t/ha), and was at par with the RDF, 75% RDF + FYM(@10 t/ha) and 75% RDF. LAI failed to produce any noteworthy response with various date of sowing, though maximum LAI observed with the 30th November sowing. Moreover, better LAI registered with the recommended dose of fertilizer (RDF) and showed parity with the all the treatments except control and 50% RDF + FYM (@10 t/ha).

Yield attributing parameter

All yield attributing parameter showed significant response with various main and subplot treatments. Highest number of tillers registered with the early date of sowing compared to late sowing condition. Data revealed that, more tiller number /m^2 was observed with the 15th November sowing and was at par with the 1st November sown crop. Amongst different nutrient management practices, more this parameter found with the RDF + FYM (@10 t/ha) and was at par with the 75% RDF + FYM(@10 t/ha). Effective tillers/m^2 showed momentous change with various main and subplot treatments, highest effective tillers registered with the 15th November sowing and significantly better to other main plots allotments. With diverse nutrient management practices, highest effective tillers number observed with the 75% RDF + FYM (@10 t/ha) and was at par with the RDF + FYM (@10 t/ha).

Further, table 1 revealed that more dry matter accumulation (g/m^2) at 90 DAS observed with the 15th November sowing and was at par with the early date of sowing (i.e. 1st November). With various subplot treatments, highest dry matter accumulation found with the RDF + FYM (@10 t/

Table 1: Effect of various treatments on growth, yield attribute and yield of wheat (pooled data of two years).

Treatment	Plant height (at 60 DAS)	LAI (at 60 DAS)	Tillers (No./m^2)	Effective tillers (No./m^2)	Dry matter accumulation (g/m^2) (90 DAS)	Grain/ spike (No.)	Test weight (g)	Grain yield (q/ha)	Straw yield (q/ha)	Biological yield (q/ha)	Harvest index (%)
Date of sowing											
1st November	96.64	3.29	286.32	247.36	623.12	37.01	40.50	35.07	64.25	99.32	35.31
15th November	89.39	3.41	311.16	284.65	645.21	35.66	38.11	37.31	76.56	111.87	33.35
30th November	91.66	3.89	225.73	194.32	481.21	31.11	38.35	27.30	58.69	85.99	31.75
15th December	81.24	3.03	151.85	107.33	396.58	23.77	38.03	21.66	40.12	61.78	35.06
S.Em±	1.44	0.53	9.06	3.21	8.26	0.76	0.87	0.81	3.54	3.31	0.82
C.D. (P=0.05)	4.03	NS	28.13	9.78	25.63	2.13	NS	2.33	10.36	10.55	2.36
Nutrient management											
Control	72.67	2.49	188.32	140.21	384.65	24.46	36.07	18.19	32.32	50.51	36.01
50% RDF	86.33	3.11	269.11	214.32	466.33	27.17	37.13	23.31	41.03	64.34	36.23
75% RDF	91.36	3.01	232.87	197.36	508.32	29.11	39.03	28.81	46.98	75.79	38.01
RDF	98.68	3.52	346.45	288.65	569.32	40.66	38.33	35.06	54.13	90.19	39.98
50% RDF + FYM (@10 t/ha)	73.67	2.71	212.36	190.66	509.66	35.23	37.00	34.92	57.98	92.90	37.59
75% RDF + FYM(@10 t/ha)	94.11	3.36	381.23	336.54	612.36	37.41	40.83	37.47	60.12	97.59	38.40
RDF + FYM(@10 t/ha)	100.66	3.19	385.77	308.58	644.51	38.05	41.23	36.67	58.14	94.81	38.68
S.Em±	3.12	0.16	7.98	9.02	17.69	1.25	0.67	1.21	4.13	4.58	0.66
C.D. (P=0.05)	9.08	0.52	23.01	29.59	50.21	3.66	1.51	3.71	12.16	13.97	1.72
CV (%)	12.54	17.69	11.20	19.95	14.66	17.98	13.65	15.45	17.14	11.23	10.23

NS = Non Significant

ha) and was at par with the 75% RDF + FYM (@10 t/ha) and statistically better to other options. More number of grain/spike observed with the early date of sowing (1st November) and was at par with the 15th November and appreciably better to other main plots treatments. Amid a range of subplot treatments, highest grain/spike registered with the RDF and was at par with the RDF + FYM (@10 t/ha) and 75% RDF + FYM (@10 t/ha). The enhanced early vegetative growth in terms of higher leaf area index, dry matter accumulation and vigorous root system resulted in more spike which consequently increased the number of spike bearing tillers significantly. Test weight failed to produce any momentous response with various main plot assignments, though utmost test weight observed with the 1st November sowing. However, with various sub plot treatments, more test weight observed with the RDF + FYM(@10 t/ha) and was at par with the 75% RDF + FYM(@10 t/ha) and statistically better to other treatments. Stimulated vegetative growth of wheat on account of adequate and prolonged supply of essential nutrients in treatment receiving FYM to 75% RDF or RDF manifested itself in increased number of effective tillers, grain/spikes and test weight. Similar beneficial effects of INM on yield attributes of wheat have been reported by Sharma *et al.* (2009).

Yield parameters

Yield component gave significant response with various main and subplot treatments, however amongst main plot treatments highest grain yield registered with the 15th November (37.01 q/ha) sowing, and was at par with the early sowing i.e. 1st November (35.07 q/ha). These treatment increases 72.25 and 61.91 % more grain yield over the extreme late sowing condition i.e. 15th December. Moreover 15th November sowing gave good response compared to extreme early sowing i.e. 1st November, this finding from this experiment is very vital, as most of the location in the eastern zone of India usually rice harvesting often late and this leads to delayed wheat sowing, and as per our result within 15th November sowing gave good response. This becomes very vital information for farming community in this zone. On perusal of data on the economic and biological yield of wheat, significant superiority of treatments receiving RDF

Table 2: Effect of various treatments on nutrient uptake and economics of wheat (pooled data of two years)

Treatment	Nutrient uptake by crop (kg/ha)			Total nutrient uptake (kg/ha)	Economics		
	N	P	K		Cost of cultivation (₹/ha)	Net return (₹/ha)	B:C ratio
Date of sowing							
1st November	100.3	15.11	82.12	197.53	37,189	32,397	1.87
15th November	105.0	16.02	106.89	227.91	38,913	40,453	2.04
30th November	97.01	12.21	83.44	192.66	37,884	24,583	1.64
15th December	68.32	8.97	78.00	155.29	36,478	19,787	1.54
S.Em±	2.36	0.37	1.52	7.87			
C.D. (P=0.05)	6.74	1.03	4.63	22.07			
Nutrient management							
Control	46.63	8.23	51.25	106.11	20,154	17,402	1.86
50% RDF	57.21	11.66	82.23	151.1	25,365	22,457	1.88
75% RDF	63.98	13.25	90.23	167.46	30,548	29,698	1.97
RDF	97.98	15.92	97.41	211.31	37,081	34,154	1.92
50% RDF + FYM (@10 t/ha)	86.02	14.01	94.01	194.04	32,458	33,012	2.01
75% RDF + FYM(@10 t/ha)	109.69	17.98	103.7	231.37	36,007	40,987	2.13
RDF + FYM(@10 t/ha)	103.23	16.87	99.63	219.73	46,457	39,791	1.85
S.Em±	4.56	0.80	3.56	11.81			
C.D. (P=0.05)	13.98	2.29	9.87	34.45			
CV (%)	16.77	13.65	14.81	15.13			

or RDF in combination with FYM was observed over the unfertilized control during both the years of study (Table 1). With assorted subplot treatments, more grain yield subjugated with the 75% RDF + FYM(@10 t/ha), and was at par with the RDF + FYM(@10 t/ha), RDF and 50% RDF + FYM (@10 t/ha).

These treatment increase grain yield by 105.91, 101.59, 92.74 and 91.97 %, over the control subplot treatment. The increase in grain yield of wheat might be due to the increased availability of essential nutrients to the crop resulting from the cumulative effect of organic sources of nutrient applied to wheat crop. Similar results have also been reported by Ba-Momen *et al*. (2007).

Further table 1 exposed that more straw yield observed with the 15th November sowing, and was significantly superior to other main plot assignment. Sub plot treatments showed that, amongst various nutrient management aspect revealed that, more straw yield found with the 75% RDF + FYM(@10 t/ha), and was at par with all other treatments except control and 50 and 75% RDF. The 15th November sowing, gave more biological yield of wheat crop and drastically better to other main plots treatments. Moreover, with various subplot treatments, better this parameter found with the 75% RDF + FYM (@10 t/ha) and was at par with all other treatments, except control and 50 and 75% RDF application. The beneficial effect of conjoint use of inorganic and organic sources of nutrients can be due to the release of nutrients from the organic sources thorough mineralization, and this leads to more grain, straw and biological yield of wheat crop. Harvest index revealed that, 30th November sowing gave least harvest index and significantly poor to all other main plot treatments. With various sub plot treatments, more harvest index registered with the normal recommended dose of fertilizer and was at par with the 75% RDF + FYM(@10 t/ha) and RDF + FYM(@10 t/ha), and statistically better to other treatments.

Nutrients removal

Nutrient uptakes by crop, significantly improves with different date of sowing and fertility levels (Table 2). Maximum, NPK uptake observed with early date of sowing i.e 15th November compared to extreme late sowing condition i.e. 15th December. More nitrogen uptake was observed with 15th November and was at par with all other treatments and notably better to extreme late sown condition. More nitrogen removal observed with the 75% RDF + FYM (@10 t/ha) and was at par with RDF + FYM(@10 t/ha) and significantly better to other subplot treatments. Uptake of primary nutrient is better under vigorous crop growth due to enhance yield attributing parameters (Deshmukh *et al*., 2007, Mukherjee, 2010). Phosphorus uptake was more create with the 15th November sowing and was at par with the 1st November, and statistically better to other main plot treatments. Amongst various nutrient management practices, more phosphorus uptake found with the 75% RDF + FYM (@10 t/ha) and was at par with the full dose of RDF + FYM(@10 t/ha). Potassium uptake was more associated with the 15th November sowing and significantly better to other main plot assignments. With various subplot, highest potassium uptake registered with the 75% RDF + FYM (@10 t/ha) and showed parity with the RDF + FYM (@10 t/ha), RDF and 50% RDF + FYM (@10 t/ha). Total nutrient uptake gave noteworthy response with various treatments. The 15th November sowing gave highest nutrient removal by crop and statistically better to other main plot treatments. With various nutrient management assignment more removal of total nutrient registered with the 75% RDF + FYM (@10 t/ha) and significantly better to all other treatments except RDF + FYM(@10 t/ha) and RDF.

Economics

Economics revealed that, more net return observed in 15th November sowing (₹ 40,453), with highest benefit cost ratio (2.04) and was followed by 1st November sowing. Amongst various nutrient management, highest net return (₹ 40,987) and benefit: cost ratio (2.13) observed with 75% RDF + FYM (@10 t/ha).

Based on above study it is concluded that wheat sowing upto 15th November along with 75% RDF + FYM (@10 t/ha) may produce higher yield, higher NPK uptake and more remuneration than recommended dose of fertilizers.

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