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Effect of integrated nutrient management on yield of wheat (*Triticum aestivum* L.) under in Indo-Gangetic Plains

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Abstract

An experiment was conducted during *rabi* season in 2017-18 and 2018-19 at Crop Research Centre of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (U.P.) to study the Effect of integrated nutrient management on yield of wheat (*Triticum aestivum* L.) under in Indo-Gangetic Plains. The experiment was laid out in randomized block design with fourteen treatment of nutrient management viz., Control (T-1), Recommended NPK (T-2), FYM@ 5t/ha+Recommended NPK(T-3), Recommended NPK+Bio-stimulant-G 25Kg/ha (T-4), Recommended NPK +Bio-stimulant-L@ 625ml/ha foliar spray each at 40,55&70 DAS (T-5),Recommended NPK and foliar spray of NPK-P 1% and Bio-stimulant-L @ 625 ml/ha at 70 DAS (T-6),FYM @5 t/ha+ Recommended NPK+ Bio-stimulant-G 25kg/ha (T-7),FYM @ 5 t/ha+NPK-G@ 200 kg/ha+ NPK-Biofertilizer+Urea@ 20 kg/ha at 40 &55 DAS (T-8), FYM@ 5t/ha+NPK-G 200kg+Bio-stimulant-G 25kg/ha+ Urea @ 20kg/ha at 40 &55 DAS (T-9), FYM @5t/ha+ NPK-G 200 kg/ha +NPK Bio fertilizer+Urea and foliar spray NPK-P @ 1% at 55 &70 DAS (T-10),FYM@ 5 t/ha+ NPK-G@ 200kg/ha+ NPK-Bio fertilizer+NPK-P @ 1% foliar spray (T-11), FYM @ 5t/ha+ NPK 200 kg/ha + NPK-Bio-fertilizer+ Urea @ 20 kg/ha basal &40 DAS and foliar spray Bio-stimulant-L 625ml/ha (T-12), FYM @5t/ha+ NPK-G @200 kg/ha + NPK-bio fertilizer + Urea and foliar spray of NPK-P &Bio-stimulant –L at 40,55& 70 DAS (T-13), FYM @5t/ha+ NPK-G @200 kg/ha + NPK-bio fertilizer and foliar spray of NPK-P &Bio-stimulant –L at 40,55& 70 DAS (T-14) were laid out in RBD and replicated thrice taking wheat var. DBW -71 as test crop. The maximum growth parameter viz., plant population in running meter, plant height (cm), numbers of tillers in running meter and dry matter accumulation (g per running row length) were recorded with the application of (T-14) FYM @5t/ha+NPK-G @ 200kg/ha+ NPK-bio fertilizer+Urea @20 kg/ha and foliar spray NPK-P@ 1% & Biostimulant –L 625ml/ha at 55 &70 DAS which was at par with the application(T-13) FYM @5t/ha+NPK-G @200 kg/ha +NPK-bio fertilizer and foliar spray NPK-P @1% & Biostimulant-L 625 ml/ha at 40, 55 & 70 DAS. Which was significantly superior over all treatments at all stages of observations. The improvement in yield attributes and yield of crop was recorded with the application of (T-14) FYM @5t/ha+NPK-G @ 200kg/ha+ NPK-bio fertilizer+Urea @20 kg/ha and foliar spray NPK-P@ 1% & Biostimulant –L 625ml/ha at 55 &70 DAS and lowest yield attributes and yield was recorded in control.

Keywords: INM, plant height, yield attributes, yield

Introduction

Wheat (*Triticum aestivum* L.) being a major cereal crop has been cultivated in India and belong to family Poaceae. India is firmly occupying the second position among the wheat producing countries in the world after China. Wheat and rice serve as life sustaining crops for our population and thus, considered to be the cornerstone of nation's food security system. In India, Uttar Pradesh is leading wheat growing state with an area of 9.65 million ha (36.6%), production of 26.87 million tonnes (39.3%) and productivity of 2785 kg/ha. Wheat productivity in the state is however far lower than that in Punjab (4.3 tonnes/ha) and Haryana (4 tonnes /ha) accounted to late sowing after long duration rice varieties and harvest of sugarcane, poor seed replacement rate, lack of quality seed, imbalanced fertilization, unscientific water management and poor mechanization etc. In western Uttar Pradesh wheat sowing is delayed up to end of December and sometimes even to I week of January leading to severe yield reduction. Delayed sowing enforces maturity under the influence of high temperature and by and large, farmers attempt to make amend it by excessive application of nutrients particularly nitrogen ignoring yield physiology in constrained environments.

Under this situation integrated nutrient management (INM) is a better approach for supplying nutrition to the crop by including organic and inorganic sources of nutrients. The application of organic manuring and crop residue had significantly effect on physical properties of a soil under the rice –wheat system in Punjab (Singh *et al.* 2007) [16].

Integrated nutrient management (INM) means judicious and efficient use of mineral fertilizer, organic manures and bio-fertilizers in an integrated manner, to get the maximum productivity and maintain soil fertility.

In this endeavor proper blend of organic and inorganic fertilizer is important not only for increasing yield but also for sustaining soil health (Baloch *et al.*, 2006 and Bakht *et al.*, 2007) [2, 3]. Wheat is an important cereal crop and requires a good supply of nutrients especially nitrogen for its growth (Kumar *et al.*, 2004) [10] and yield. Application of farm manure ameliorates the soil permeability (Bali *et al.*, 1986) [4] and improve soil fertility. Application of organic materials alone or in combination with inorganic fertilizers helped in the proper nutrition and maintenance of soil fertility (Sameem *et al.*, 2002). Hussain *et al.*, (1988) [7] reported that the efficiency of chemical fertilizers increased with the use of organic manures. Farmyard manures is a valuable amendment and may replace the chemical fertilizers. It stimulates plant growth and may help to prevent plant disease, besides increasing the quality of the produce. Integration of FYM with inorganic N sources increases productivity and monetary returns of wheat and improves soil fertility (Sarma *et al.* 2007) [15]. Application of biofertilizer which is environment friendly and low cost input, with organic and inorganic fertilizer as a part of an integrated nutrient management strategy and play significant role in plant nutrition. The role of bio fertilizer is perceived as growth regulators besides biological nitrogen fixation collectively leading to much higher response on various growth and yield attributing characters. Seaweed has been found effective for enhancing yield, pest and frost resistance in vegetable, fruits, flowers, cereals and pulses. Seaweed extracts had beneficial effect on seed germination and plant growth (Thirumal and Thangum *et al.*, 2003). Thus judicious use of organic manure, biofertilizer and organic fertilizer helps in sustain production of wheat.

Materials and Methods

A field experiment was conducted at the Crop Research Centre of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (U.P.) during Rabi season both years. The experiment laid out in randomized block design with three replicated. The soil of the experimental field was Gangetic alluvial having sandy clay loam texture with pH 7.6. It was moderately fertile, with available nitrogen (226.85kg/ha), available phosphorus (27.54 kg/ha), available potassium (170.58kg/ha), organic carbon (0.49%) and electrical conductivity (0.44 dsm⁻¹ at 25°C). The treatment details are as Control (T-1), Recommended NPK (T-2), FYM@ 5t/ha+ Recommended NPK(T-3), Recommended NPK+Bio-stimulant-G 25Kg/ha (T-4), Recommended NPK +Bio-stimulant-L@ 625ml/ha foliar spray each at 40,55&70 DAS (T-5),Recommended NPK and foliar spray of NPK-P 1% and Bio-stimulant-L @ 625 ml/ha at 70 DAS (T-6),FYM @5 t/ha+ Recommended NPK+ Bio-stimulant-G 25kg/ha (T-7),FYM @ 5 t/ha+NPK-G@ 200 kg/ha+ NPK-Biofertilizer+Urea @ 20 kg/ha at 40 &55 DAS (T-8), FYM@ 5t/ha+NPK-G 200kg+Bio-stimulant-G 25kg/ha+ Urea @ 20kg/ha at 40 &55 DAS (T-9), FYM @5t/ha+ NPK-G 200 kg/ha +NPK Bio fertilizer+Urea and foliar spray NPK-P @ 1% at 55 &70 DAS (T-10),FYM@ 5 t/ha+ NPK-G@ 200kg/ha+ NPK-Bio fertilizer+NPK-P @ 1% foliar spray (T-11), FYM @ 5t/ha+ NPK 200 kg/ha + NPK-Bio-fertilizer+ Urea @ 20 kg/ha basal &40 DAS and foliar spray Bio-stimulant-L 625ml/ha (T-12), FYM @5t/ha+ NPK-G @200 kg/ha + NPK-bio fertilizer + Urea and foliar spray of NPK-P

&Bio-stimulant –L at 40,55& 70 DAS (T-13), FYM @5t/ha+ NPK-G @200 kg/ha + NPK-bio fertilizer and foliar spray of NPK-P &Bio-stimulant –L at 40, 55 & 70 DAS (T-14) were applied. DBW-71 variety were sown by pora method with spacing of 20.0 cm and seed rate was 125 kg/ha. The recommended dose of fertilizer for wheat are 80, 60,40kg of N,P₂O₅ and K₂O/ha respectively. Full dose of P₂O₅, K₂O and 50 % of N were applied at the time of sowing. Remaining does of nitrogen were applied to broadcasting. The field was kept free from weeds by manual hoeing. Plant protection measures and irrigation whenever required were provided in same manner for all the treatments. Regular biometric observation were recorded at periodic intervals of 30 DAS, 60 DAS, 90 DAS and at harvest stages of selected plants. Yield attributes parameters were recorded just before harvesting of crop. Harvesting was done when the spike matured and plant was dried up. Thus grain yield of each plot was recorded as kg/plot. After that threshing of the crop was done with mini thresher, straw was collected separately. Statistical data were analysed by standard procedure by Gomez & Gomez, (1984) [6].

$$CD = SEM \pm \sqrt{2} \times t_{0.05}$$

CD = Critical difference

SEM± = Standard error of mean

T_{0.05} = Value of percentage point of 't' distribution for error degree of freedom at 5 percent level of significance.

Result and Discussion

Effect on growth

The result of the present study indicated that growth parameters of plant such as plant height, dry matter accumulation and tiller per meter row length of wheat crop were significantly influenced by different integrated nutrient management treatments. All fertilized treatments improve the productivity relative to control (unfertilized) (Tab.1.1). However, nutrients management strategies had pronounced effect at all the stages during both the years. Plant height tended to increase with advancement in crop age upto at harvest, although the rate of increment was highest between 60 and 90 DAS during both the years. The data further revealed that crop receiving nutrients had taller plants as against control, though such variations were significant at all the stages during both the years. At 30 days stage, tallest plants were measured in crop fertilized with FYM-5 t ha⁻¹ + NPK-G200 kg ha⁻¹ + NPK bio-fertilizer inoculation +Urea 20kg/ha at 40 DAS and foliar application of NPK-P @ 1% with bio-stimulant @ 625 ml/ha at 55 &70 DAS(T-14) had highest plant height (34.20 &32.20 cm) which was at par with FYM- 5 t ha⁻¹ + NPK –G @200 kg ha⁻¹ + NPK bio-fertilizer and foliar application of NPK-P @1% with Bio-stimulant-L @625ml/ha at 40,55 &70DAS (T-13), FYM @ 5 t ha⁻¹ + NPK 200kg ha⁻¹ +NPK bio-fertilizer+ basal application of urea &40DAS and foliar application of bio-stimulant–L 625ml/ha at 55&70DAS (T-12) in first year significantly superior over rest of the treatments and in second year investigation all treatment are at par except control and recommended NPK. At 60 days stage, maximum height (85.30 cm & 81.60 cm) of plant was obtained under T-14 treatment being significantly taller than those for the rest of the fertilizers treatment. The difference in the plant height were at par all treatment except control, respectively during both the years.Plant height at 90 DAS registered at increased 18.17 % (2017-18) and 17.75 % (2018-19) over Recommended NPK. The increase was however significant only with FYM+NPK-G+NPK-biofertilizer +broadcasting of Urea and foliar spray of NPK-

P@ 1% with Biostimulant-L (T-14) based nutrients applications at all the stages during both the years. Almost similar trend was observed at all the stages. The control plots resulted significant reduction in plant height compared to other treatments at 30, 60, 90 DAS and at harvest. Control plot produces shorter plant at all the growth stages measured in studies. The reason for higher values of growth parameter can be discussed in the light of fact that crop under these treatments had comparatively make easily extractable and more availability of nutrients than other treatments which resulted in better crop growth like plant population, plant height and ultimately more dry matter accumulation it might due to application of organic matter, bio-fertilizer, urea and bio-stimulant help in higher nutrient mobility and therefore, plant uptake more nutrients by reducing nutrient losses through leaching, runoff etc. Application of various organic manures stimulated the plant growth, microbial activity and higher activity of soil enzymes (Knapp *et al.*, 2010) [19]. The higher plant height and dry matter accumulation with the application of FYM may also be due to the fact that in FYM mineralization is rapid, large portion of nitrogen, phosphorus and potassium in FYM is inorganic fractions (Willrich *et al.*, 1974 and Channabasaganowda *et al.*, 2008) [17, 5]. This was due to direct effect of nutrient availability on yield as evident from maximum dry matter resulted from treatment where more nutrient added to soil and in low nutrient available to crop resulted in lower nutrient uptake by wheat and thereby reduction in dry matter of wheat and lower plant character. The similar result was reported by Singh *et al.* (2007) [16].

Effect on yield attributes

Yield attributes, which determine yield, is the resultant of the vegetative development of the plant. All the attributes of yield *viz.*, number of effective tillers meter row length, number of grain per spike, spike length, test weight, grain yield, straw yield, biological yield and harvest index were significantly influenced by different integrated nutrient management methods. The improvement in yield attributes and yield of crop was recorded significantly highest with the application of (T-14) FYM-5 t ha⁻¹ +NPK-G 200 kg ha⁻¹ + NPK bio-fertilizer inoculation +Urea 20kg/ha and foliar application of NPK-P@1% with bio-stimulant@625ml/ha (T-14). However all other treatments of integrated nutrient management were comparable to each other in respect of yield. The all growth attributes specially LAI help in plant photosynthesis, which ultimately help in yield attributes. Similar result were reported by Ram & Mir (2006) [13].

Effect on yield

Yield is the result of co-ordinate interplay of various growth characters. Grain yield (kg/ha) and straw yield (kg/ha) were significantly influenced by different treatments. Grain yield showed significant variation under different nutrient management practices in wheat. All the nutrient management options increased grain yield significantly over control. Further perusal of the data given in (Table 1.3) indicated that recommended NPK increased the yield by 3214Kg/ha (22%) over control and further addition of FYM over recommended NPK led to additional increase of (6.4 %) 3420kg/ha though it was significant. Similarly use of recommended NPK + Bio-stimulant-G@ 25kg/ha, recommended NPK + Bio-stimulant-L @ 625 ml/ha foliar spray each at 40,55&70 DAS, recommended NPK+NPK-P 1% foliar spray at 70 DAS+Bio-stimulant-L @ 625ml/ha foliar spray at 70 DAS, FYM

@5t/ha+ recommended NPK + Bio-stimulant-G 25kg/ha increased grain yield over control by 3958kg/ha (50.26 %), 3862kg/ha (46.62 %), 3716kg/ha (41.07%),4110kg/ha (56.03) being non-significant among themselves. Data further indicated that application of FYM @5t/ha + NPK-G@ 200 kg/ha+ NPK-bio-fertilizer + Urea @ 20kg/ha at 40DAS +NPK-P @ 1% foliar spray at 55&70 DAS (T-10) and FYM@ 5t/ha +NPK-G @200 kg/ha+NPK-bio-fertilizer +Urea@ 20kg/ha at 40DAS and foliar spray NPK-P @1% along with Bio-stimulant-L 625ml/ha at 55&70DAS(T-14) increased grain yield over where urea was not applied i.e. FYM @5t/ha + NPK-G @200kg/ha+ NPK-bio-fertilizer + NPK-P @ 1% foliar spray at 40,55&70DAS(T-11) and FYM@ 5t/ha +NPK-G @200 kg/ha+NPK-bio-fertilizer and foliar spray NPK-P @1% along with Bio-stimulant-L 625ml/ha at 40,55&70 DAS(T-13) by 3631 to 3627,4751 to 4764kg/ha (0.52 to 0.82%,6.4 to 6.4%) respectively during both the year. Effect of foliar spray of NPK -P with FYM @5t/ha + NPK-G@ 200 kg/ha+ NPK-bio-fertilizer + Urea @ 20kg/ha at 40DAS +NPK-P @ 1% foliar spray at 55&70 DAS (T-10) was found significant over the same level of NPK -G+ NPK Bio-fertilizer+ Urea (T-8) during both the years by 3562kg/ha(1.9%). Further the effect of Bio-stimulant -L (T-14) was also found significant with treatment FYM @5t/ha + NPK-G@ 200 kg/ha+ NPK-bio-fertilizer + Urea @ 20kg/ha at 40DAS +NPK-P @ 1% foliar spray at 55&70 DAS+ Bio-stimulant-L @ 625 ml/ha foliar spray each at 55 &70 DAS when compared with the treatment without application of bio-stimulant the treatment (T-10) i.e. FYM@5t/ha+NPK-G200 kg/ha+NPK-biofertilizer+ Urea@ 20kg/ha at 40 DAS +NPK-P @ 1% foliar spray at 55 &70 DAS found significantly increased grain yield (30.84%) in first year and (30.27) in second year of investigation. Among all the treatments, the highest grain yield was recorded in 'FYM @5t/ha + NPK-G@ 200 kg/ha+ NPK-bio-fertilizer + Urea @ 20kg/ha at 40DAS and foliar spray of NPK-P @ 1% with Bio-stimulant-L @ 625 ml/ha at 55&70 DAS (T-14) during both the years respectively. Application of higher fertilizer doses *viz* FYM + NPK-G+ NPK-bio-fertilizer + Urea +NPK-P @ 1% foliar spray at 55&70 DAS+ Bio-stimulant-L foliar spray each at 55 &70 DAS during both the year, respectively resulted in highest grain yield which was statistically at par with FYM + NPK-G + NPK-bio-fertilizer and foliar spray of NPK-P @ 1% with Bio-stimulant-L each at 40,55&70 DAS, but significantly superior to rest of the treatments. For these reasons, higher growth attributes contributes higher yield attributes. The high yield this is due to the availability of more nutrients i.e the results in nutrients application was better due to additional supply of nutrients through azotobacter which might have increased nutrient uptake and better translocation of nutrients. Afzal *et al.*, (2005) [1] also reported that phosphate solubilizing micro-organism (PSM) in combination with phosphorus fertilizer and organic manure significantly improved grain and biological yield of wheat. This result can be attributed due to marked improvement plant height, leaf area index, dry matter accumulation, yield and better nutrient utilization. Adequate availability of nutrients resulted in enhanced growth attributes and yield attributes. Number of grain per spike, ear length, test weight, grain yield, straw yield, biological yield and harvest index were significantly influenced by different integrated nutrient management method (Manna *et al.*, 2005) [11], (Kaushik *et al.*, 2012) [8] and Patel, *et al.*, 2014) [12].

Table 1.1: Effect of nutrient management strategies on plant height (cm) at various crop growth stages

Symbol	Treatments	Plant height (cm)							
		30 DAS		60 DAS		90 DAS		At harvest	
		2017-18	2018-19	2017-18	2018-19	2017-18	2018-19	2017-18	2018-19
T ₁	Control	24.30	25.10	62.60	63.90	87.20	88.60	88.20	89.50
T ₂	Recommended NPK	27.20	28.10	77.30	77.80	94.10	95.20	98.20	99.60
T ₃	FYM @5t/ha+ Recommended NPK	29.40	30.30	77.50	77.90	96.10	96.30	99.50	100.20
T ₄	Recommended NPK + Bio-stimulant-G@ 25kg/acre	30.30	31.30	78.50	79.10	104.50	100.20	108.30	109.20
T ₅	Recommended NPK + Bio-stimulant-L @ 625 ml/ha foliar spray each at 40,55&70 DAS	30.20	31.20	78.20	78.90	101.90	102.50	107.65	107.20
T ₆	Recommended NPK+NPK-P 1% foliar spray at 70 DAS + Bio-stimulant-L @ 625 ml/ha foliar spray at 70 DAS	30.10	31.20	77.90	78.60	100.50	104.90	105.60	105.80
T ₇	FYM @5t/ha+ Recommended NPK + Bio-stimulant-G 25kg/acre	30.50	31.60	79.20	79.60	107.60	107.90	110.40	111.90
T ₈	FYM @5t/ha + NPK-G @ 200kg/ha +NPK-bio-fertilizer + Urea @ 20kg/ha each at 40& 55DAS	29.80	30.70	77.50	78.20	97.50	98.30	102.50	103.20
T ₉	FYM @5t/ha+ NPK-G 200kg+ Bio-stimulant-G 25kg/acre + Urea @ 20kg each at 40&55 DAS	30.50	31.40	78.70	79.30	106.80	107.10	109.40	110.50
T ₁₀	FYM @5t/ha + NPK-G@ 200 kg/ha+ NPK-bio-fertilizer + Urea @ 20kg/ha at 40DAS +NPK-P @ 1% foliar spray at 55&70 DAS	29.90	30.90	77.80	78.50	99.90	101.40	104.80	106.40
T ₁₁	FYM @5t/ha + NPK-G @200kg/ha+ NPK-bio-fertilizer + NPK-P @ 1% foliar spray at 40,55&70DAS	29.90	30.80	77.50	78.50	99.10	99.80	104.20	105.60
T ₁₂	FYM @5t/ha + NPK 200kg/ha +NPK-bio-fertilizer+ Urea @ 20 kg/ha each as basal & 40 DAS + Bio-stimulant-L @ 625 ml/ha foliar spray each at 55& 70 DAS	31.60	31.70	80.50	80.00	109.10	109.80	111.80	112.60
T ₁₃	FYM @5t/ha + NPK-G @200kg/ha+ NPK-bio-fertilizer + NPK-P @ 1% foliar spray at 40,55&70DAS + Bio-stimulant-L @ 625 ml/ha foliar spray each at 40,55&70 DAS	32.70	31.70	82.60	80.30	109.30	109.80	112.10	112.80
T ₁₄	FYM @5t/ha + NPK-G@ 200 kg/ha+ NPK-bio-fertilizer + Urea @ 20kg/ha at 40DAS +NPK-P @ 1% foliar spray at 55&70 DAS+ Bio-stimulant-L @ 625 ml/ha foliar spray each at 55 &70 DAS	34.20	32.20	85.30	81.60	111.20	112.10	113.60	113.90
	SEM (±)	1.12	1.14	2.90	2.76	3.80	3.81	3.93	3.96
	C.D. (P=0.05)	3.21	3.24	8.27	7.88	10.85	10.89	11.22	11.31

Table 1.2: Effect of nutrient management strategies on yield attributes

Symbol	Treatments	Yield attributes									
		Number of tillers m ⁻¹ row length		Ear length (cm)		Spikelets per spike		Grains per spike		1000-grain weight (g)	
		2017-18	2018-19	2017-18	2018-19	2017-18	2018-19	2017-18	2018-19	2017-18	2018-19
T ₁	Control	61.9	63.80	6.10	6.90	10.10	10.80	36.80	36.96	35.73	35.88
T ₂	Recommended NPK	77.17	79.35	7.20	7.80	13.30	13.70	37.91	38.10	36.23	36.37
T ₃	FYM @5t/ha+ Recommended NPK	80.49	81.87	7.60	8.10	13.60	13.90	38.60	38.71	36.43	36.54
T ₄	Recommended NPK + Bio-stimulant-G@ 25kg/acre	97.16	98.29	9.80	10.10	15.60	15.90	44.80	44.97	38.12	38.27
T ₅	Recommended NPK + Bio-stimulant-L @ 625 ml/ha foliar spray each at 40,55&70 DAS	92.80	93.58	9.30	9.40	15.20	15.50	43.61	43.65	37.92	38.05
T ₆	Recommended NPK+NPK-P 1% foliar spray at 70 DAS + Bio-stimulant-L @ 625 ml/ha foliar spray at 70 DAS	89.86	90.74	8.40	8.80	15.20	15.50	42.80	42.91	37.42	37.67
T ₇	FYM @5t/ha+ Recommended NPK + Bio-stimulant-G 25kg/acre	102.61	103.77	10.80	10.90	15.90	16.40	46.30	46.48	38.62	38.79
T ₈	FYM @5t/ha + NPK-G @ 200kg/ha +NPK-bio-fertilizer + Urea @ 20kg/ha each at 40& 55DAS	81.58	82.96	7.90	8.30	14.50	14.80	39.11	39.22	36.82	36.94
T ₉	FYM @5t/ha+ NPK-G 200kg+ Bio-stimulant-G 25kg/acre + Urea @ 20kg each at 40&55 DAS	100.80	101.69	10.50	10.70	15.70	16.10	45.53	45.67	38.30	38.42
T ₁₀	FYM @5t/ha + NPK-G@ 200 kg/ha+ NPK-bio-fertilizer + Urea @ 20kg/ha at 40DAS +NPK-P @ 1% foliar spray at 55&70 DAS	86.59	88.22	8.30	8.60	14.90	15.20	41.82	41.94	37.22	37.35
T ₁₁	FYM @5t/ha + NPK-G @200kg/ha+ NPK-bio-fertilizer + NPK-P @ 1% foliar spray at 40,55&70DAS	86.26	87.89	8.20	8.50	14.80	15.10	40.73	40.87	37.00	37.14
T ₁₂	FYM @5t/ha + NPK 200kg/ha +NPK-bio-fertilizer+ Urea @ 20 kg/ha each as basal & 40 DAS + Bio-stimulant-L @ 625 ml/ha foliar spray each at 55& 70 DAS	104.36	105.63	11.20	11.40	16.10	16.80	47.80	47.93	39.33	39.52
T ₁₃	FYM @5t/ha + NPK-G @200kg/ha+ NPK-bio-fertilizer + NPK-P @ 1% foliar spray at 40,55&70DAS + Bio-stimulant-L @ 625 ml/ha foliar spray each at 40,55&70 DAS	104.77	105.74	11.30	11.50	16.10	16.80	48.50	48.63	39.81	39.97
T ₁₄	FYM @5t/ha + NPK-G@ 200 kg/ha+ NPK-bio-fertilizer + Urea @ 20kg/ha at 40DAS +NPK-P @ 1% foliar spray at 55&70 DAS+ Bio-stimulant-L @ 625 ml/ha foliar spray each at 55 &70 DAS	106.21	107.49	12.40	12.60	17.40	17.90	49.66	49.78	40.12	40.29
	SEM (±)	3.47	3.52	0.36	0.37	0.56	0.58	1.63	1.63	1.40	1.40
	C.D. (P=0.05)	9.92	10.05	1.03	1.06	1.60	1.65	4.64	4.66	3.99	4.01

Table 1.3: Effect of nutrient management strategies on yield (kg ha⁻¹)

Symbol	Treatments	Yield (kg ha ⁻¹)							
		Grain		Straw		Biological		Harvest index (%)	
		2017-18	2018-19	2017-18	2018-19	2017-18	2018-19	2017-18	2018-19
T ₁	Control	2634	2654	4214	4299	6848	6953	38.46	38.17
T ₂	Recommended NPK	3214	3226	4821	5162	8035	8388	40.00	38.46
T ₃	FYM @5t/ha+ Recommended NPK	3420	3428	5062	5416	8482	8844	40.32	38.76
T ₄	Recommended NPK + Bio-stimulant-G@ 25kg/ha	3958	3967	5581	5831	9539	9798	41.49	40.49
T ₅	Recommended NPK + Bio-stimulant-L @ 625 ml/ha foliar spray each at 40,55&70 DAS	3862	3878	5484	5778	9346	9656	41.32	40.16
T ₆	Recommended NPK+NPK-P 1% foliar spray at 70 DAS + Bio-stimulant-L @ 625 ml/ha foliar spray at 70 DAS	3716	3721	5314	5622	9030	9343	41.15	39.83
T ₇	FYM @5t/ha+ Recommended NPK + Bio-stimulant-G 25kg/ha	4110	4124	5722	5939	9832	10063	41.80	40.98
T ₈	FYM @5t/ha + NPK-G @ 200kg/ha +NPK-bio-fertilizer + Urea @ 20kg/ha each at 40& 55DAS	3562	3575	5236	5613	8798	9188	40.49	38.91
T ₉	FYM @5t/ha+ NPK-G 200kg+ Bio-stimulant-G 25kg/ha + Urea @ 20kg each at 40&55 DAS	4087	4096	5672	5856	9759	9952	41.88	41.16
T ₁₀	FYM @5t/ha + NPK-G@ 200 kg/ha+ NPK-bio-fertilizer + Urea @ 20kg/ha at 40DAS +NPK-P @ 1% foliar spray at 55&70 DAS	3631	3657	5274	5619	8905	9276	40.77	39.42
T ₁₁	FYM @5t/ha + NPK-G @200kg/ha+ NPK-bio-fertilizer + NPK-P @ 1% foliar spray at 40,55&70DAS	3612	3627	5229	5595	8841	9222	40.86	39.33
T ₁₂	FYM @5t/ha + NPK 200kg/ha +NPK-bio-fertilizer+ Urea @ 20 kg/ha each as basal & 40 DAS + Bio-stimulant-L @ 625 ml/ha foliar spray each at 55& 70 DAS	4172	4183	5674	5856	9846	10039	42.37	41.67
T ₁₃	FYM @5t/ha + NPK-G @200kg/ha+ NPK-bio-fertilizer + NPK-P @ 1% foliar spray at 40,55&70DAS + Bio-stimulant-L @ 625 ml/ha foliar spray each at 40,55&70 DAS	4463	4477	6025	6178	10488	10655	42.55	42.02
T ₁₄	FYM @5t/ha + NPK-G@ 200 kg/ha+ NPK-bio-fertilizer + Urea @ 20kg/ha at 40DAS +NPK-P @ 1% foliar spray at 55&70 DAS+ Bio-stimulant-L @ 625 ml/ha foliar spray each at 55 &70 DAS	4751	4764	6319	6479	11070	11243	42.92	42.37
	SEm (±)	145.01	145.49	203.13	212.02	348.07	357.40	1.52	1.48
	C.D. (P=0.05)	414.15	415.54	580.15	605.56	994.10	1020.75	NS	NS

Conclusion

On the basis of results summarized above, it can be concluded that application of (T-14) FYM@ 5t/ha +NPK-G @200 kg/ha+NPK-bio-fertilizer +Urea@ 20kg/ha at 40DAS and foliar spray NPK-P @1% along with Bio-stimulant-L 625ml/ha at 55&70DAS gave best results in respect to all parameters. The lowest yield was recorded in control.

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