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Effect of FYM and bio-stimulants on growth and yield of wheat (*Triticum aestivum* L.)

Lali Jat, NS Rana, Balveer, Dimple, Sushila Aechra and Surender Dhayal

Abstract
Wheat (*Triticum aestivum* L.) is the staple food of 40 percent human population across the globe and requires adequate supply of nutrients especially nitrogen for its growth and yield. Therefore, an investigation entitled "Effect of nutrient management in wheat for improving fertilizer use efficiency, productivity and soil health" was conducted to sustain and enhance the productivity and soil health through novel sources of nutrients and their mode of applications on wheat variety DBW 71 with 14 treatments consisting of control, basal applications of recommended NPK(80:60:40)/NPK Granules (200 kg ha^{-1}) + FYM (5 t ha^{-1}) + Bio-stimulant granules (62.5 kg ha^{-1}) +NPK Bio-fertilizer(seed treatment) and top dressing of urea 20 (kg ha^{-1})/ bio-stimulant(625ml/ha)/ NPK Powder (1%) sprays (40/55/70 DAS) in various combinations in RBD with 3 replications at crop research centre of SVPUA&T, Meerut (U.P.) during *rabi* 2017-19.The soil was well drained sandy loam, low in organic carbon and available nitrogen, medium in available phosphorus and potassium with slightly alkaline pH.
The results of the study revealed that wheat when grown with incorporation of FYM +Bio-stimulant –L attainted significantly better growth as reflected by higher plant population, taller plants, higher LAI, LAD CGR,RGR,NAR, and higher dry matter accumulation across the stages. Application of FYM@ 5t/ha+NPK-G@200kg/ha + NPK-bio-fertilizer + Urea @ 20kg/ha and foliar spray of NPK-P @ 1% along with bio-stimulant-L@ 625 ml/ha (T-14) resulted in maximum accumulation of dry matter @ 151g/m^1 at harvest in comparison to recommended NPK, while it remained at par with nutrient management practice involving application of FYM@ 5t/ha+NPK-G@200kg/ha + NPK-bio-fertilizer and foliar spray of NPK-P @ 1% along with bio-stimulant-L@ 625 ml/ha (T-13) and FYM @5t/ha +NPK 200kg/ha + NPK-bio-fertilizer + Urea@ 20 kg/ha each as basal &40 DAS + Bio-stimulant-L @ 625ml/ha (T-12) upto 90 DAS and at harvest stages. Yield attributes and yields *viz.* effective tillers m^{-1} row length, number of grains $ear^{-1,}$ test weight (40.2g), grain yield (4757.5 kg ha^{-1}) and straw yield (6399 kg ha^{-1}) as against respective value of 78.3, 38, 36.3, 3220, 4991.5 with recommended NPK and 62.85, 36.8, 35.8, 2644 and 4256.5 with no treatment application.

Keywords: Productivity, bio-stimulant, 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. Wheat is an important cereal crop and requires a good supply of nutrients especially nitrogen for its growth (Kumar *et al*.,) [6] and yield. Application of farm manure ameliorates the soil permeability (Bali *et al*.,) [1] 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 (Sameen *et al*.,) [11]. (Bhardwaj) reported that the efficiency of chemical fertilizers increased with the use of organic manures. Continuous use of chemical fertilizer is assumed to be a major cause of deterioration of soil health and water pollution. To maintain high productivity and sustainability of soil and crop, balanced use of both mineral fertilizer and organic manures is indispensable.

Under such a condition, there is a greate urgency to explore an alternate sources, which can supplement partially or wholly the use of costly input i.e., chemical fertilizer and also to protect the fragile ecosystem. 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.

Seaweed extracts had beneficial effect on seed germination and plant growth (Thirumal and Thangum *et al*., 2003) [17]. To overcome the problem of nutrient deficiency and to increase wheat yield, the farmers are applying chemical fertilizer. However, the chemical fertilizers are expensive and the small farmers cannot afford to use these fertilizers in suitable amount and balanced proportion. Under such condition integrated use of chemical and organic fertilizer/manures can play an important role to sustain soil fertility and crop productivity.

Material and Method

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 ^{0}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/acre (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/acre (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/acre+ 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, P_2O_5 and K_2O/ha respectively. Full dose of P_2O_5, K_2O 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 such as CGR, RGR, NAR were recorded at periodic intervals of 30 DAS, 60 DAS,90 DAS and at harvest stages of selected plants.

Leaf Area Index (LAI)

From the samples collected for dry matter estimation, leaves of 5 plants were plucked at 30, 60 and 90 DAS and leaf area was measured with the help of leaf area meter (LA-3100). After recording leaf area, these leaves were again mixed with the samples of dry matter estimation. The leaf area for each sample so recorded was averaged to give leaf area per plant. Land area per plant was used to compute LAI at each stage by following relationship **(**Watson**)**

$$LAI = \frac{\text{Leaf area } (cm^2)}{\text{Land area } (cm^2)}$$

Crop Growth Rate (CGR)

Mean crop growth rate of a plant for a time "t" is defined as the increase in dry weight of plant material from a unit area per unit of time. It was calculated with the following formula **(**Radford**)** from periodic dry matter recorded at different stages:

$$CGR\ (g\ m^{-2}day^{-1}) = \frac{W_2 - W_1}{t_2 - t_1} \times \frac{1}{A}$$

Where

W_1 = Total dry weight of plant at time t_1
W_2= Total dry weight of plant at time t_2
t_1 = Time at first observation, and
t_2 = Time at second observation
A = represents the ground area (m^2)

Relative Growth Rate (RGR)

The relative growth rate of a plant at an instant for a time interval "t" is defined as the increase in dry weight of plant material per unit of material present per unit of time. The mean relative growth rate (RGR) of the crop was calculated by the following formula **(**Radford**)**.

$$RGR\ (gg^{-1}day^{-1}) = \frac{\text{Loge } W_2 - \text{Loge } W_1}{t_2 - t_1}$$

Where

W_1 = Total dry weight of plant at time t_1
W_2 = Total dry weight of plant at time t_2
t_1 = Time at first observation
t_2 = Time at second observation

Result and Discussion

Wheat plant population was higher in crop receiving nutrients from external sources irrespective of the treatments in comparison to control. However, such effects were non-significant. Further perusal of the data suggested that number of plants per m^{-1}varied from 41.5 in crop receiving no nutrients to 48.2 in crop fertilized with FYM @5 t ha^{-1} + Recommended NPK along with Bio-stimulant-G 25 Kg/acre. Plant height increased with advancement in crop age upto at harvest, though the rate of increment was highest between 60 and 90 DAS during both the years. At 60 days stage, maximum height (83.45 cm) of plant was obtained under T-14 treatment being significantly superior to rest of the treatments. The difference in the plant height was at par to all the treatments except control plots. Plant height at harvest

registered an increase of 17.96% over recommended NPK. The increase was however significant only with FYM+NPK-G+NPK-bio-fertilizer +broadcasting of Urea and foliar spray of NPK-P@ 1% with Bio-stimulant-L (T-14) based applications at all the stages. Almost similar trend was observed at all the growth stages. FYM improves the growth of plants directly or indirectly as it adds large amount of macro and micro nutrients organic matter and humic substances which are produced in the soil by the decomposition of organic material and this material is very useful for the growth of the plant Noreen *et al*.

Dry matter accumulation

Dry matter accumulation increased progressively with advancement in crop age irrespective of the treatment as depicted in Figure 1. indicates that all the nutrient management practices increased plant dry matter significantly over the control, however the rate of increase slowed down with age and it was lowest after 90 days stage. Observations indicated that the CGR was lowest between 90 DAS till harvest and attained maximum value between 30-60 days and then declined consistently till crop maturity. Wheat plants grown under nutrient management practices significantly recorded higher CGR over control at all stages. Crop fed with FYM-5 t ha^{-1}+ NPK-G 200 kg ha^{-1} + NPK bio-fertilizer inoculation +Urea @ 20kh/ha and foliar spray of NPK-P 1% along with bio-stimulant @ 625ml/ha (T-14) registered highest CGR at 30 to 60 DAS (3.28 g m^{-2} day^{-1}), 60 to 90 DAS (0.66 g m^{-2} day^{-1}) and 90 days till harvest (0.05 g m^{-2} day^{-1}). The highest RGR 0.0464g $g^{-1}d^{-1}$ was recorded only 30 to 60 DAS in investigation. Lowest value of RGR was recorded in control over rest of the treatments during the years. Application of organic manures stimulates the plant growth, microbial activity and higher activity of soil enzymes (Khan *et al*.,) [5]. The taller plant height and higher accumulation of dry matter was observed with the incorporation of FYM which could be possibly due to the rapid mineralization of FYM that supply large portion of nitrogen, phosphorus and potassium (Willrich and Channabasanagowda). Also, incorporation of FYM increases the population of beneficial microorganisms such as N-fixers, Phosphorus solublizers and increases the activity of nitrogenase & urease enzyme as observed by (Sepat and Singh). 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).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 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/acre 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. 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), (Kaushik *et al*., 2012) and Patel, *et al*., 2014) [7, 4, 9].

Table 1: Effect of nutrient management strategies on plant population and plant height (cm)

	Treatments	Plant population (No m^{-1})	Plant height			
			30 DAS	60 DAS	90 DAS	At harvest
		Pool	Pool	Pool	Pool	Pool
T_1	Control	41.55	24.70	63.25	87.90	88.85
T_2	Recommended NPK	46.05	27.65	77.55	94.65	98.90
T_3	FYM @5t/ha+ Recommended NPK	47.60	29.85	77.70	96.20	99.85
T_4	Recommended NPK + Bio-stimulant-G@ 25kg/acre	48.10	30.80	78.80	102.35	108.75
T_5	Recommended NPK + Bio-stimulant-L @ 625 ml/ha foliar spray each at 40,55&70 DAS	45.05	30.70	78.55	102.20	107.43
T_6	Recommended NPK+NPK-P 1% foliar spray at 70 DAS + Bio-stimulant-L @ 625 ml/ha foliar spray at 70 DAS	45.60	30.65	78.25	102.70	105.70

T_7	FYM @5t/ha+ Recommended NPK + Bio-stimulant-G 25kg/acre	48.20	31.05	79.40	107.75	111.15
T_8	FYM @5t/ha + NPK-G @ 200kg/ha +NPK-bio-fertilizer + Urea @ 20kg/ha each at 40& 55DAS	43.55	30.25	77.85	97.90	102.85
T_9	FYM @5t/ha+ NPK-G 200kg+ Bio-stimulant-G 25kg/acre + Urea @ 20kg each at 40&55 DAS	44.10	30.95	79.00	106.95	109.95
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	42.85	30.40	78.15	100.65	105.60
T_{11}	FYM @5t/ha + NPK-G @200kg/ha+ NPK-bio-fertilizer + NPK-P @ 1% foliar spray at 40,55&70DAS	42.95	30.35	78.00	99.45	104.90
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	43.05	31.65	80.25	109.45	112.20
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	43.25	32.20	81.45	109.55	112.45
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	43.60	33.20	83.45	111.65	113.75
	S.Em (±)	0.03	0.46	0.46	0.88	0.29
	C.D. (P=0.05)	NS	1.33	NS	NS	0.84

Table 2: Effect of nutrient management strategies on leaf area index and leaf area duration at various crop growth stages

	Treatments	**Leaf Area Index Leaf Area duration**				
		30 DAS	**60 DAS**	**90 DAS**	**30-60 DAS**	**60-90 DAS**
		Pool	Pool	Pool	Pool	Pool
T_1	Control	0.21	1.77	3.34	29.55	76.38
T_2	Recommended NPK	0.23	1.96	3.88	32.74	87.52
T_3	FYM @5t/ha+ Recommended NPK	0.23	1.98	3.90	33.02	88.03
T_4	Recommended NPK + Bio-stimulant-G@ 25kg/acre	0.26	2.08	4.10	35.01	92.61
T_5	Recommended NPK + Bio-stimulant-L @ 625 ml/ha foliar spray each at 40,55&70 DAS	0.25	2.06	4.07	34.54	91.77
T_6	Recommended NPK+NPK-P 1% foliar spray at 70 DAS + Bio-stimulant-L @ 625 ml/ha foliar spray at 70 DAS	0.25	2.05	4.02	34.39	90.94
T_7	FYM @5t/ha+ Recommended NPK + Bio-stimulant-G 25kg/acre	0.26	2.12	4.14	35.64	93.71
T_8	FYM @5t/ha + NPK-G @ 200kg/ha +NPK-bio-fertilizer + Urea @ 20kg/ha each at 40& 55DAS	0.23	1.98	3.93	33.17	88.59
T_9	FYM @5t/ha+ NPK-G 200kg+ Bio-stimulant-G 25kg/acre + Urea @ 20kg each at 40&55 DAS	0.26	2.10	4.11	35.28	93.09
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	0.25	2.00	4.00	33.77	90.05
T_{11}	FYM @5t/ha + NPK-G @200kg/ha+ NPK-bio-fertilizer + NPK-P @ 1% foliar spray at 40,55&70DAS	0.24	2.01	3.97	33.49	89.61
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	0.27	2.15	4.18	36.09	94.74
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	0.27	2.16	4.28	36.39	96.59
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	0.27	2.26	4.54	37.97	102.01
	S.Em (±)	0.00	0.01	0.02	0.09	0.39
	C.D. (P=0.05)	0.01	0.02	0.07	0.25	1.13

Table 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
	S.Em (±)	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

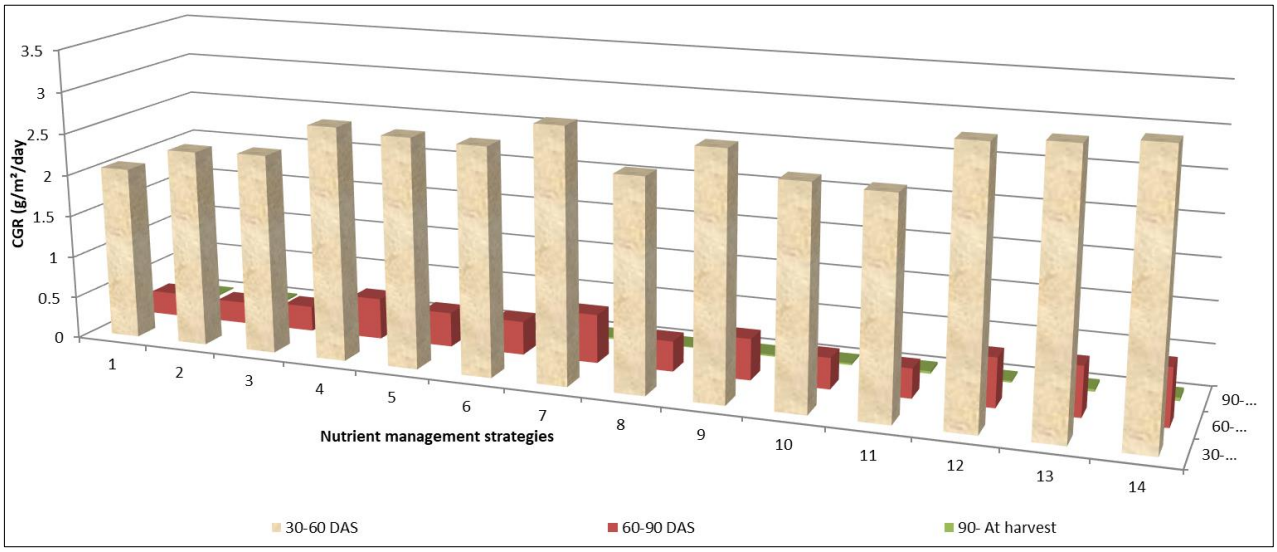

Fig 1: Effect of nutrient management strategies on crop growth rate at different stages

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 such as plant population, plant height, dry matter accumulation, CGR, RGR, NAR, LAI and LAD. The lowest yield was recorded in control. Nutrient use efficiency is typically divided into two interactive components (i.e., the amount of nutrient taken up by plants in relation to nutrient supply) and the efficiency of nutrient utilization, which informs the biomass produced by the unit of nutrient incorporated by plants. The existence of relevant constraints in improving these components while maintain food quality has been highlighted (Barraclough *et al*.,) [2].

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