Effect of Integrated Nutrient Management (INM) on growth parameters and yield of wheat (*Triticum aestivum* L.)

ABSTRACT

An experiment was conducted during *rabi* season of 2021-22 at Agronomy Research Farm, Dolphin PG college of science and agriculture Chunni Kalan, Fatehgarh Sahib Punjab. India. The experiment consists of fourteen treatments were laid out in Randomized Block Design (RBD) with three replications. As per experiment the results revealed that the growth parameters were significantly influenced by different integrated nutrient management at successive growth stages of crop except 30 DAS. Crop growth rate increased progressively with increase in duration of wheat crop. Crop growth rate was maximum up to 90 DAS and thereafter, a slow increase in growth was obtained up to harvest. Among the integrated nutrient management, 100% RDF +25% N through (vermicompost) + ZnSO4 @ 25 kg ha^{-1} proved to found better as regarding of plant height (92.25 cm), dry matter accumulation (274.65 g m^{-2}) and number tillers m^{-2} (92.43 m^{-2}) at harvest stage in respective years. Whereas leaf area index was measured maximum at 60 DAS after than it declined. The minimum growth parameters were observed under control. Maximum grain yield (55.32 q ha^{-1}), straw yield (81.14 q ha^{-1}), biological yield (136.46 q ha^{-1}) and harvest index (40.53 %) was associated with the plot fertilized with 100% RDF +25% N through (vermicompost)+ $ZnSO_4$ @ 25 kg ha^{-1}

Keywords: Growth, Plant height, Dry matter, LAI, Tillers and Yield.

INTRODUCTION

Wheat (*Triticum aestivum* L.) being a major cereal crop cultivated in India and abroad. It belongs to Poaceae family. Wheat generally grown in *rabi* season and it can be successful grown in the tropical and sub-tropical climates and also in the temperate zone. Wheat can tolerate to severe cold and snow and resume growth with the setting in warm weather in spring. It can be cultivated from sea level to an altitude of 3300 meters. The most favorable climatic condition for wheat cultivation is cool and moist weather during the vegetative growth period followed by dry, warm weather for the grain to mature and ripening. The optimum temperature range for ideal germination of wheat seed is 20-25^0 C. Warm and dry climatic conditions are not suited for wheat during the heading and flowering stage, excessively high or low temperatures and drought are harmful to wheat. Cloudy weather with high humidity and low temperatures is conducive for rust attack. It requires about 25-30^{0}C optimum average temperature at the time of ripening. The temperature at the time of grain filling and development are very crucial for yield. Temperatures above 25^{0}C tend to depress grain weight. Wheat contains more protein in the form of gluten than other cereals crop .Wheat occupied an acreages about 215.29 million ha with production of 730.84 million metric tons with productivity of 3390 kg ha^{-1} (Anonymous, 2021). In India it is grown on 29.55 million ha^{-1} (13.43% global area) with the production of 101.20 million tonns (1.3% rises previous year) and productivity about 3424 kg ha^{-1} (Anonymous, 2021). In Uttar Pradesh wheat occupied about 9.78 million ha^{-1} achieved rank first in production (31.99 million tons) with productivity (3269 kg ha^{-1}). But the productivity is comparatively lower than that the Punjab (5030 kg ha^{-1}) and Haryana (4410 kg ha^{-1})

Present time adoption of intensive cropping system will meet the food as per the demands of increasing population, it requires high input energy, which are not only responsible for environment degradation but also increased the cost of cultivation. After the green revolution, production of crops has increased to a great extent due to the use of chemical fertilizers but their indiscriminate use has led to soil sickness, ecological hazards and depletion of other sources of energy. The recent energy crisis, high fertilizer cost and low purchasing power of the farming community have made it necessary to re-think alternatives. Under these situations, INM is a good option in food grain security as well as to maintain soil health. Integrated nutrient management (INM) is the combined use of mineral fertilizers with organic resources such as cattle manures, crop residues, urban/rural wastes, composts, green manures *etc*. It contributes in attaining agronomical feasible, economically viable, environmentally sound and sustainable high crop yields in cropping systems by enhancing nutrient use efficiency and soil fertility, reducing nitrogen losses due to nitrate leaching and emission of greenhouse gases. Kaur *et al.* (2018) reported that the plant height (cm), dry matter accumulation (g), leaf area index and number of tillers (m^{-2}) of wheat improved significantly by the application of FYM @10t ha^{-1} and phosphorus @ 80 kg P_2O_5 ha^{-1}.

FYM is a great source of supplements and contributed towards build-up of organic matter in soil. Nitrogen is a crucial component for ideal working of crops. The increment in eco-friendly production of wheat can be made conceivable by far reaching selection of progressed innovations of which fertilizer administration especially that of nitrogen though organic manure can play a key part. Hence, present investigation was carried out to study the growth, yield and nutrient uptake behaviour of wheat to define optimum dose under integrated use of FYM. (Choudhary *et al.,* 2022)

Among the micronutrients, zinc deficiency appears to be the most widespread owing to intensive agricultural practices, use of high analysis NPK fertilizers and limited or no application of Zinc by farmers. At present about 48.1% of Indian soils are rated as very low in available zinc. (Kumar *et al.,* 2022)

MATERIALS AND METHODS

An experiment was conducted on Effect of Integrated Nutrient Management (INM) on growth parameters of wheat (*Triticum aestivum* L.) during *rabi* season of 2021-22 at the Agronomy Research Farm, Dolphin PG college of Science and Agriculture Chunni Kalan Fatehgarh sahib Punjab. India The experiment consists of fourteen treatments ***i.e.*** T_1-100% RDF (Recommended dose of fertilizer), T_2. 75% RDF, T_3. 75% RDF + $ZnSO_4$ @25kg ha^{-1} T_4. 75% RDF + sulphur @40kg/$ha^{-1,}$ T_5. 75%RDF +25% N through FYM + *Azotobacter* T_6. 75% RDF + $ZnSO_4$ @25kg ha^{-1} + Sulphur @40kg ha^{-1}, T_7. 100% RDF +25% N through (vermicompost) + $ZnSO_4$ @25kg ha^{-1} and Control (T_8) treatments were laid out in Randomized Block Design (RBD) with three replications. The experimental field was well drained and leveled in order to determine the fertility status and soil class, soil samples were collected randomly from different places of the experimental field with the help of soil auger at the depth of 0-15 cm for physico-chemical analysis before execution of the fertility treatments. The soil was silty loam with the pH of (7.8) with EC (0.14,dS/m). The organic carbon content of soil was (0.44%) with available nitrogen (189 kg ha^{-1}), available phosphorous (15 kg ha^{-1}), and available potassium (178 kg ha^{-1}). The experimental site falls under the sub-tropical climate of Indo-Gangatic alluvial plains zone (IGP) having alluvial calcareous soil and located at 26°47' N latitude and 82°12’ E longitude with an altitude of 113 m above the mean sea level. Variety PBW 154 was shown proper moisture stage on 18 Nov, 2021-22. the seed was treated with @ 1 packet *Azotobacter* with 10 kg seed of Wheat by making the pest with the help of 500 ml water and 50 g gur heated and cools down and mix with seed. After dry seeds in shade and use for sowing**.** The seeds were placed in manually opened furrows at the depth of 5 cm below with the row spacing of 20 cm apart. The seeds were applied informally in each and every plots @ 100 kg ha^{-1}. Nitrogen, phosphorus and potassium fertilizer were applied in the forms of Urea, DAP and Muriatic of potash @ 120, 60 and 40 kg ha^{-1}, respectively. Full dose of phosphorus, potassium and half dose of nitrogen were applied as basal dressing at the time of sowing and rest half dose of nitrogen was applied as two split doses at the time of first irrigation and second irrigation.

Leaf area index was calculated by the following relationship (Mckee 1964)

$$\text{Leaf area index} = \frac{\text{Total leaf area (cm}^2\text{)}}{\text{Total land area (cm}^2\text{)}}$$

RESULT AND DISCUSSION

Growth Parameters

1. Plant Height (cm)

Plant height increased progressively with increase in duration of wheat crop (table 1). Crop growth rate was maximum up to 90 DAS and thereafter, a slow increase in growth was obtained up to harvest. The plant height was significantly influenced by the various integrated nutrient management practices. The taller plants were recorded with the application of 100% RDF +25% N through (vermicompost) + ZnSO4 @ 25 kg ha^{-1} (T_7), which was statistically at par with T_1, T_5, and T_6 treatments, respectively at all the successive growth stages of crop. This might be due to increment of additional nutrient applied as the form of different component of INM. The increase components seems to have been broad about by increases in amount of growth substances and naturally occurring phytohormones with increase nitrogen supply. Probably the increase in auxin, cell division and cell enlargement by the supply of higher level of INM brought about increased in the plant height. Pandey *et al*. (2004). Whereas the minimum plant height was recorded in control at all the growth stages this might be due to lack of the nutrient available in soil. The similar finding given by Khattak *et al.* (2015).

2. Dry Matter Accumulation

The dry matter accumulation increased with increasing the rate of photosynthesis (Table 2). The highest dry matter accumulation was recorded under 100% RDF +25% N through (vermicompost) + ZnSO4 @ 25 kg ha^{-1} (T_7) treatments, which was statistically at par with T_1, T_5 and T_6 treatment, respectively. While it was significantly superior over rest of treatments at all successive growth stages of plant. The significant improvement dry matter accumulation was observed when increased the different component of nutrients sources. This was not only provides nutrients but also improved physical condition of soil in respect of granulation, friability and porosity they also increased cation exchange capacity and phosphate and sulphate availability of soil, low nitrogen loses due to slow release of nutrient from different components of integration. The biological role of the nitrogen as an essential constituent of chlorophyll in harvesting of solar energy and the regulation of cellular metabolisms of protein, structural units and biological catalyst etc. Thus these mechanism improved the plant height, number of leaves, leaf area index and number of tillers which have ultimately enhanced the dry matter accumulation (Jain, 2012).

3. Leaf Area Index

Integrated nutrient management practices significantly influenced on leaf area index at 30, 60 and 90 DAS in both the years experimentation (table 3). Among the integrated nutrient management, 100% RDF +25% N through (vermicompost) + ZnSO4 @ 25 kg ha^{-1} was received maximum leaf area index, which was statistically at par with each and every treatment except control at 30 DAS. The leaf area index progressively increased upto 90 DAS after that it decreased. The maximum value of leaf area index (2.36) 90 DAS. This might be due to maximum availability of nutrient in soil cause more nutrient uptake by in plant, which increased although growth parameters *i.e.* plant height, number of leaf $plant^{-1}$, number of tillers m^{-2} which has ultimately enhanced the leaf area index. Bachhao *et al.* (2018).

4. Number of Tillers (m^{-2})

Obvious from the data have been summarized in (Table-4) result revealed that the number of tillers significantly increased with the increasing of different components of plant nutrients. The number of tillers were increased progressively up to 90 DAS and thereafter decreased. As par described data, the maximum number of tillers (m^{-2}) were observed with the application of 100% RDF +25% N through (vermicompost) + ZnSO4 @ 25 kg ha^{-1}, which was significantly higher over control. However, it was at par with all the integrated nutrient management sources. This might be due to increased the application of different components of INM in soil results enhanced the nutrient status of the soil as well as increased the microbial activity of soil, which might be due to plant get favorable condition for growth and development as well as chlorophyll content by canopy of plants caused more photosynthesis which was ultimately increased number of tillers m^{-2}. Similar findings was reported by Akhtar *et al.* (2018).

Productivity Parameters

It is obvious from the data given in Table 5 clearly shows that among the productivity parameters viz. grain yield, straw yield, biological yield and harvest index significantly affected by different treatment combinations of organic manure and inorganic fertilizers. Maximum grain yield (55.32 q ha^{-1}), straw yield (81.14 q ha^{-1}), biological yield (136.46 q ha^{-1}) and harvest index (40.53 %) was associated with the plot fertilized with 100% RDF +25% N through (vermicompost)+ $ZnSO_4$ @ 25 kg ha^{-1} has been statically par with the plot fertilized with 75%RDF + 25% N through FYM + *Azotobacter*. Minimum grain yield (46.10 q ha^{-1}), straw yield (78.65 q ha^{-1}), biological yield (124.75 q ha^{-1}) and harvest index (36.95 %) has been associated with the control plot. The results of the present investigation are also in agreement with the findings of **Choudhary *et al.* (2022),**

SUMMARY AND CONCLUSSION

The different component of integrated nutrient management were increased with increase the growth parameters as par duration of the crop. Among the integrated nutrient management, application of 100% RDF +25% N through (vermicompost) + ZnSO4 @ 25 kg ha^{-1} recorded maximum growth parameters in respect of plant height, dry matter accumulation $plant^{-1}$, leaf area index and number of tillers at different growth stages of crop. Similarly maximum yield was also associated with the treatment fertilized with 100% RDF +25% N through (vermicompost) + ZnSO4 @ 25 kg ha^{-1}. However, the minimum value of growth parameters and yield parameters was received under control during both the years of experimentation.

Table-1 Plant height (cm) at subsequent growth stages of wheat as influenced by various integrated nutrient management (INM)

S.N	Treatments	Plant height (cm)		
		30 DAS	60 DAS	90DAS
1	100% RDF (Recommended dose of fertilizer)	28.40	51.40	88.75
2	75% RDF	28.41	49.12	88.10
3	75% RDF + $ZnSO_4$ @25 kg ha^{-1}	28.31	50.49	88.50
4	75% RDF + Sulphur @40 kg ha^{-1}	28.13	50.15	88.10
5	75%RDF +25% N through FYM + *Azotobacter*	28.14	53.15	90.47
6	75% RDF + $ZnSO_4$ @25 kg ha^{-1} + Sulphur @40 kg ha^{-1}	28.32	50.46	89.12
7	100% RDF +25% N through (vermicompost)+ $ZnSO_4$ @25kg ha^{-1}	28.42	54.41	92.25
8	Control	28.50	49.00	87.15
	C.D at 5 % SEm±	N/A 0.767	2.89 1.36	3.15 1.39

Table-2 Dry matter accumulation (g m^{-2}) at successive growth stages of wheat crop as influenced by various integrated nutrient management (INM).

S.N	Treatments	Dry matter accumulation (g m^{-2})			
		30 DAS	60 DAS	90DAS	Harvest
1	100% RDF (Recommended dose of fertilizer)	29.14	97.10	165.48	264.72
2	75% RDF	29.52	94.15	159.13	260.14
3	75% RDF + $ZnSO_4$ @25 kg ha^{-1}	29.46	96.15	164.36	262.35
4	75% RDF + Sulphur @40 kg ha^{-1}	29.48	95.90	161.46	259.35
5	75%RDF +25% N through FYM + *Azotobacter*	29.50	100.12	168.98	267.65
6	75% RDF + $ZnSO_4$ @25 kg ha^{-1} + Sulphur @40 kg ha^{-1}	29.41	98.56	167.55	260.14
7	100% RDF +25% N through (vermicompost)+ $ZnSO_4$ @25kg ha^{-1}	28.41	108.35	170.63	274.65
8	Control	28.51	93.16	158.19	258.10
	C.D at 5 % SEm±	N/A 0.79	7.98 2.60	3.64 2.40	6.56 3.50

Table-3 Leaf area index at successive growth stages of wheat crop as influenced by various integrated nutrient management (INM).

S.N	Treatments	Leaf area index (LAI)		
		30 DAS	60 DAS	90DAS
1	100% RDF (Recommended dose of fertilizer)	1.62	1.84	1.92
2	75% RDF	1.65	1.79	1.90
3	75% RDF + $ZnSO_4$ @25 kg ha^{-1}	1.63	1.80	1.92
4	75% RDF + Sulphur @40 kg ha^{-1}	1.62	1.77	1.80
5	75%RDF +25% N through FYM + *Azotobacter*	1.64	1.87	2.10
6	75% RDF + $ZnSO_4$ @25 kg ha^{-1} + Sulphur @40 kg ha^{-1}	1.65	1.85	1.95
7	100% RDF +25% N through (vermicompost)+ $ZnSO_4$ @25kg ha^{-1}	1.63	1.96	2.36
8	Control	1.64	1.75	1.78
	C.D at 5 % SEm ±	N/A 0.04	0.24 0.04	0.15 0.05

Table-4 Number of tillers per m^{-2} of wheat as influence by various integrated nutrient management (INM)

S.N	Treatments	Number of tillers (m^{-2})			
		30 DAS	60 DAS	90DAS	Harvest
1	100% RDF (Recommended dose of fertilizer)	45.10	90.15	89.14	85.13
2	75% RDF	45.12	86.42	85.12	84.13
3	75% RDF + $ZnSO_4$ @25 kg ha^{-1}	45.12	89.50	88.41	82.61
4	75% RDF + Sulphur @40 kg ha^{-1}	45.14	82.14	82.13	81.12
5	75%RDF +25% N through FYM + *Azotobacter*	46.41	92.16	91.14	91.13
6	75% RDF + $ZnSO_4$ @25 kg ha^{-1} + Sulphur @40 kg ha^{-1}	46.31	90.45	90.14	89.10
7	100% RDF +25% N through (vermicompost)+ $ZnSO_4$ @25kg ha^{-1}	47.50	93.52	92.43	91.53
8	Control	41.47	85.16	84.10	83.12
	C.D at 5 % SEm ±	N/A 1.21	3.35 2.36	3.45 2.33	3.67 2.31

Table-5 Effect of Integrated Nutrient Management (INM) on productivity Parameters

S.N	Treatments	Grain Yield (q ha^{-1})	Straw Yield (q ha^{-1})	Biological Yield (q ha^{-1})	Harvesting index (%)
1	100% RDF (Recommended dose of fertilizer)	49.39	77.73	127.12	38.85
2	75% RDF	45.70	77.46	123.16	37.10
3	75% RDF + $ZnSO_4$ @25 kg ha^{-1}	48.35	78.50	126.85	38.11
4	75% RDF + Sulphur @40 kg ha^{-1}	47.85	77.65	125.50	38.12
5	75%RDF +25% N through FYM + *Azotobacter*	52.45	80.29	132.74	39.51
6	75% RDF + $ZnSO_4$ @25 kg ha^{-1} + Sulphur @40 kg ha^{-1}	50.65	79.20	129.85	39.00
7	100% RDF +25% N through (vermicompost)+ $ZnSO_4$ @25kg ha^{-1}	55.32	81.14	136.46	40.53
8	Control	46.10	78.65	124.75	36.95
	C.D at 5 %	4.00	3.54	7.34	2.35
	SE m±	1.30	2.12	3.42	1.03

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