Original Research Article

Effects of Various Nitrogen Doses and Plant Growth Regulators on Nutrient Uptake and Grain Yield of Wheat(*Triticumaestivum*L.)

ABSTRACT

This field investigation was conducted at Research Farm of BiharAgricultural University, Sabour, Bhagalpur, Bihar, during rabi season of 2019-20, to find out the effect of "Optimization of nitrogen doses for high yield potential of wheat (*Triticum aestivum* L.)" with plant growth regulators. The experiment was laid out in randomized block design comparing ten treatment of different doses of NPK fertilizer with plant growth regulators namely chlormequat chloride and tebuconazole applied at 0.2% and 0.1% respectively and replicated three times. The obtained results revealed that application of 150% recommended doses of NPK showing higher value of available nitrogen (171.82 kg ha^{-1}), available phosphorus (27.01 kg ha^{-1}) and available potassium (192.27 kg ha^{-1}) content in soil after the harvest of wheat was significantly influenced by the application of different doses of NPK, while lowest value of all three major nutrients was recorded in control. The highest nitrogen, phosphorus and potassium uptake by wheat was also recorded with the 150% RDF of NPK with growth regulator. The yields (grain yield, straw yield and biological yield) were found to be significantlymaximumintreatmentT10(150%NPK+PGRsspray)butatparwithtreatmentT7(100% RDF of NPK)ascompareto other treatments. Hence, harvest index was recorded maximum (0.45) in treatment T8 (125% RDF of N with growth regulator)andtreatmentT9(150%RDF of N+PGRsspray). The uptake of key nutrients, nitrogen, phosphorus and potassium followed a similar pattern, with the highest levels observed when applying 150% recommended doses of NPK along with growth regulators. Additionally, optimal NPK application resulted in positive nutrient balance in the soil. This investigation suggests that managing nutrient with growth regulator in wheat is an economically viable and ecologically sound approach to improve both crop production and soil health through balanced nutrition.

Keywords: Fertilizer, Nutrientlevels,nutrientuptake, PGR,wheat

1. INTRODUCTION

Wheat(*Triticumaestivum*L.)orginatedfrom SouthwestAsiaandbelongstothefamilyPoaceae. It's known for its abundant reserves of carbohydrates, distinctive protein profile, fat and minerals and also good soruce of vitamins such as thiamine ad vit-B. Wheat is referred as the "king of cereals" and a crucial staple food crop for both human and animal, providing approximately half of the world's dietary calories. Among the world's food crops wheat ranks 1st in terms of production, it grown 217.02million hectares and yield stunning 765.4 million metric tonnes worldwide. In India, wheat is cultivated on 31.45 million hectares of land, producing 107.592 million metric tons with a productivity of 3.42 metric tonnes/ha (USDA, 2020). In Bihar wheat is grown on more than 2 million hectares of land and produce 5-6million tonnes. Wheat occupies 28% of the gross cropped area of Bihar and 70% of the sown area in the Rabi season [1]. The global call for wheat is estimated to reach around 840MT by 2030 [2] and projected wheat production target for India by the year 2050 is approximately 140 MT. This prediction accounts for the increasing demand for consumption and trade caused by the growing population. Nutrient application in agricultural systems is expected to rise in the next years in order to produce more food, feed, and fiber on a limited piece of land. However this is a challenge to achieve optimum wheat production by maintaining a nutrient balanced ecosystem. Proper nutrient management is a critical factor influencing crop productivity [3]. Balanced nutrient application in crop production is a crucial step to achieving optimal growth and yield. Improper management in essential nutrients leads to yield reduction, increases susceptibility of diseases and pests, and compromised nutritional quality. Conventional practices of nutrient management only focus on the application of fertilizers to provide plants with the necessary elements for growth. However these approaches have sometimes led to nutrient imbalances in the soil, affecting not only crop performance but also environmental sustainability [2]. In order to address these challenges, modern agricultural research has explored innovative approaches aimed at optimized fertilizer use while conserving nutrient balance [2]. One of the most effective approaches to involves integration of plant growth regulators with judiciously optimized fertilizer levels. Plant growth regulators have been recently reported to enhance growth and yield of wheat [4]. Plant growth regulators are synthetic or naturally occurring compounds that influence the growth and development, including nutrient uptake, root development, and photosynthesis of plants in a targeted manner [2]. There are several phases during the growth cycle where PGRs could be applied for modification of plant growth and development. As a result, PGR's can be applied to modify plant growth and development at different phases of the growth cycle. Chlormequat, commonly known as ChlorCholineChloride (CCC), is a key agricultural growth regulator in many countries. It's an organic chloride salt and a quaternary ammonium salt. Chlormequat chloride is an organic chloride salt that accomodates equal amounts of chlormequat and chloride ions. It has a role as a plant growth retardant and an agrochemical. After the use of Chlormequat chloride, it can effectively control plant growth, shorten the internodes of plants, make plant short, strong, thick, roots developed, resistant lodging, also darkening leaf color, thickening leaves, increased chlorophyll content, and increased photosynthesis, which increase the percentage of fruit set in certain crops, improve quality, and increase yield. "By applying CCC at the beginning of stem elongation and the other PGRs at later stage, earlier to heading, cereal straw could be shortened" [5]. Tebuconazole is a triazole fungicide and it is used in agriculture to intercept the plant pathogenic fungi. This fungicide is widely used to treat wheat seeds to prevent diseases caused by *Ustilago* spp., *Tilletia* spp. and *Fusarium* spp. It shows a systemic effect, consisting of penetration of the active substance through the protective tissues of plants. It is a standard in the control of fungal diseases from the genus *Fusarium*, especially those occurring in grain ears [6]. Additionally, tebuconazole is highly efficient against yellow and brown rust. Because of its long half-life, from 49 to 610 days, tebuconazole residues stay in the environment, including the atmosphere, soil, water, fruit and vegetables and cereals [7]. Considering these factors, this investigation was conducted to determine the optimal fertilizer dosage levels in combination with growth regulators to achieve higher wheat yields (*Triticum aestivum* L). The ultimate goal of this study is to contribute to sustainable and efficient wheat production practices that not only increase yield but also promote nutrient balanced wheat.

2. MATERIALSANDMETHODS

The experiment was carried out at the research farm of Bihar Agricultural University, Sabour during the rabi season of 2019-20, to investigate the Optimal nitrogen doses for high yield potential of wheat (*Triticum aestivum* L.). This research was laid out in a randomized complete block design and the whole field was divided into three blocks each representing the replication in which each replication consists of ten treatments of different combinations. All treatments were allocated randomly in each replication. T_1-control,T_2-50%recommended dose of nitrogenous fertilizer (RDF) *i.e*. 150 kgN ha^{-1}, T_3- 75% (RDF) of N, T_4- 100% RDF of N, T_5- 125%ofN,T_6-150%RDFofN,T_7-100%RDFofNPKi.e.150:60:40 N:P: K kg ha^{-1}. T_8-125% RDF of N with PGRs spray(Chlormequat chloride @ 0.2% + Tebuconazole @ 0.1% at 45and 65 days after sowing (DAS), T_9- 150% RDF of N withPGRs spray (at 45 and 65 DAS) and T_{10}- 150% RDF of NPKwith PGRs spray at 45 and 65 DAS. The region receives an average rainfall 1207 mm, precipitating mostly between the middle of June to the middle of October. The experimental plot have sandyloam soil having organic carbon (0.55%) with pH (7.23), availablenitrogen (154.11 kg ha^{-1}), available phosphorus (24.45 kg ha^{-1}) and available potassium (184.46 kg ha^{-1}). The experimental plots were prepared by ploughing of the field. Two times crosswise ploughing was done by the power tiller and planking was followed after each ploughing to pulverize the soil. Along with weeds, root stubble and residues of other crop were removed. Land leveling is an essential component of land preparation. WheatcultivarDBW187wassownon25thNovember 2019 and harvested on 4th April 2020. Wheat seedhadsownatarowtorowspacingof20cmapart@ 100kgha^{-1}. The recommended fertilizer dose, i.e., 120:60:40kg NPKha^{-1} was applied according to the treatment. The full amount of Phosphorus and Potassium fertilizer with 1/3rd of Nitrogen fertilizer was given as basal according to treatments. The remaining Nitrogen was applied in two splits, after first irrigation at crown root initiation (CRI) and second irrigation at jointing stage respectively. As the source of nitrogen, phosphorus and potassium, Urea,DAP and MOP were used respectively. Irrigation was given to crop as and when needed according to the crop requirement and rainfall pattern. Two irritations to an approximate depth of 6 cm were given to the crop at critical stages when water availability is problem, first irrigation at CRI stage and second at flowering stage. When the crop was grown under irrigated conditions receive a total of six irrigations at critical growth stages. Weed control was achieved through two manual weeding in all treatment plots using a weeding hook as needed. Gap filling was performed ten days after sowing to maintain the required plant population. Biometric observations were recorded at intervals of 15 DAS, 30 DAS, 60 DAS, 90 DAS, and at the harvest stage.

2.1 Plant Nutrient Analysis Details

Plant sample (straw and grain) were taken at harvesting from each plot for nutrient estimation analysis, samples were oven-dried at 70^0C for 48 hours. The plant material thus obtained was grind with the help of a grinder and passed through 40 mesh sieves and preserved separately for determination of N, P, and K content. TotalNwasanalyzedbyKjeldahlmethod,Pwasdeterminedthroughspectrophotometer and potassium was obtained by flamephotometer [8]. The nitrogen,phosphorus andpotassium contentingrainandstraw weremultiplied by the respective dry matter yield to get uptake (kgha^{-1}).

Uptake of NPK by Straw

$$\text{Nutrient uptake (kg/ha)} = \frac{\text{Of NPK concentration in straw x straw yield (kg/ha)}}{100}$$

Uptake of NPK by grain

$$\text{Nutrient uptake (kg/ha)} = \frac{\text{Of NPK concentration in straw x grain yield (kg/ha)}}{100}$$

Total uptake:

Total uptake of N, P and K was calculated for each treatment separately by using the following formula**.** Total nitrogen uptake (kg ha^{-1}) =N uptake by grain + N uptake by straw and uptake of N, P and K by wheat plants was expresses in kg ha^{-1}.

2.2. Dry matter accumulations (g/m^2)

Plants available in 1m area were removed from each plot for observing dry weight of the crop. These samples were sun-dried and then put in the hot air oven and dried at 70^oC for 48 hr. to get the constant dry weight of plants expressed in gram/meter square.

2.3. Yield

2.3.1. Grain yield (q ha^{-1})

The harvested produce from the net plot area was dried under sun light and threshed to obtain grain in kg plot^{-1}.Thereafter, it was converted to q ha^{-1}.

2.3.2. Straw yield (q ha^{-1})

The straw yield was calculated by subtracting the grain yield from total biological yield and finally it was converted to q ha^{-1}.

2.3.3. Biological yield (q ha^{-1})

From each plot separately crop was harvested, bundled and weighed to get the biological yield in kg ha^{-1}. Then the total biological yield was converted to q ha^{-1}.

2.3.4. Harvest Index (%)

It was estimated with the help of grain yield and biological yield, expressed in percentage by using the formula (Donald 1968)

HI = grain yield x 100 /biological yield (straw + grain).

The collected data were subjected to statistically analysis using the analysis of variance (ANOVA) technique, following the procedure suggested by Panse and Sukhatme. Treatment comparisons are made at 5% levels of significance.

CD =S.Ed X t (0.05) (edf)

Where,

S.Em±} = standard error of treatment means

S.Ed±} = standard error of difference between treatment means

C.D = Critical difference

3. RESULTANDDISCUSSION

3.1. Growth Attributes

3.1.1. Dry matter accumulation (g m^{-2})

The effect of various treatments on accumulation of dry matter on wheat at different growth stages throughout the cultivation period. A perusal of data (fig-1) indicated that dry matter accumulation of wheat increased progressively from vegetative to maturity stage. At 30 days after sowing viz tillering stage significantly higher dry matter accumulation was recorded under the treatment with 150% RDF of NPK and growth regulator, followed by the treatment100% RDF of NPK. At jointing stage 60 days after sowing, again significantly higher dry matter accumulation was observed with the treatment 150% RDF of NPK and growth regulators and similar trend recorded. At prematurity and maturity stage similar result was also recorded where higher dry matter accumulation was recorded with the treatment 150% RDF of NPK and growth regulators while significantly lower dry matter accumulation was recorded in treatment where no fertilizers were added at different growth stages of wheat from tillering to maturity. Dry matter accumulation is the increase in the dry weight of a plant at a certain time and is influenced by a combination of factors including internal and external systems as well as dry matter. Accumulation is the cumulative effect of all growth traits, namely plant height, number of shoots and green leaves. Dry weight of the above ground parts at harvest significantly higher with increased nitrogen levels and maximum in treatment with the application of 150% RDF of NPK and growth regulator. Improved dry matter production (DMP) with increased application of nutrients was owing to the function of NPK in influencing and efficient use of sunlight via enhanced biological and insufficiency of nitrogen decreases the sunlight utilize efficiency or the facility to photosynthesise as already reported [9].This might be due to adequate supply of nutrients allowed the plant tissue to grow large and increase the chlorophyll formation and stimulated rapid rate of photosynthetic activity, consequently recorded more dry matter accumulation in comparison to its lower level this observation was recorded by [10]. [11] reported that dry matter accumulation and translocation are closely related to the yield and N application significantly affects its accumulation and translocation [12]. Similar results observed by [13] on winter wheat he reported thatthe increase in N application, the dry matter accumulation in winter wheat increased gradually from the sowing stage to the jointing stage; it increased first and then remained constant from the jointing stage to the anthesis stage, and increased and then decreased from the anthesis stage to the maturity stage.

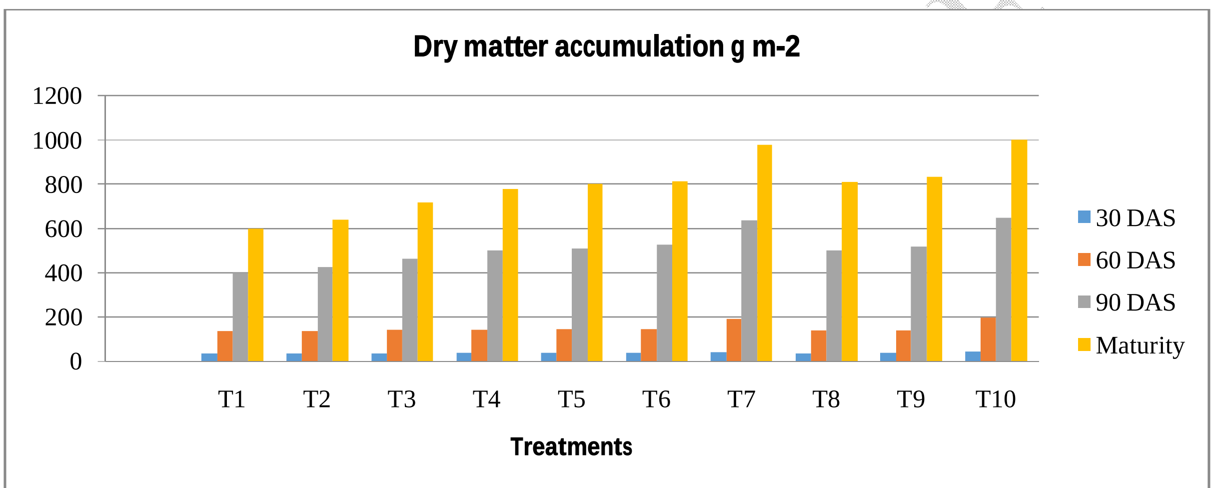

Fig-1-Effect of nitrogen doses and plant growth regulators on Dry matter accumulation (g m^{-2}) of wheat at different growth stages

3.2. Yield (q ha^{-1})

Data presented in (table-1) revealed that grain yield, straw yield, biological index and harvesting index increased significantly with increasing nitrogen levels despite the application of growth regulators over control, maximum grain yield, straw yield and biological yield was recorded in treatment with application of 150% RDF of NPK along with Chlormequat chloride + Tebuconazole (51.71, 65.38 and 117.09 q/ha respectively) found statistically at par with treatment T_7 (100 % RDF of NPK). While Harvest index was found maximum in treatment T_8 and T_9 in which 125% and 150% RDF of N with growth regulators were applied. This might be due to improvement in growth and yield attributing characters and higher photosynthetic activity. It is well-known fact that higher levels of fertilizer application enhance soil fertility and nutrient supply capacity. This increased fertility leads to improved nutrient uptake, benefiting plant growth and yield characteristics, ultimately resulting in greater grain and straw yields. These findings align with the research of [14] and [15].

Table: 1. Effect of nitrogen doses and plant growth regulators on yield parameter of wheat.

Treatment		Yield (q ha^{-1})			HI
		Grain	Straw	Biological	
T_1	Control	28.15	39.45	67.60	0.42
T_2	50% RDF of N	32.97	43.33	76.30	0.43
T_3	75% RDF of N	36.74	46.79	83.53	0.44
T_4	100% RDF of N	38.96	50.58	89.55	0.44
T_5	125% RDF of N	40.19	53.68	93.87	0.43
T_6	150% RDF of N	41.45	53.30	94.75	0.44
T_7	100% RDF of NPK	49.23	63.85	113.07	0.44
T_8	125% RDF of N with PGR (Chlormequat chloride 0.2% and Tebuconazole 0.1%)	43.06	52.02	95.08	0.45
T_9	150% RDF of N with PGR (Chlormequat chloride 0.2% and Tebuconazole 0.1%)	44.41	55.43	99.84	0.45
T_{10}	150% RDF of NPK with PGR (Chlormequat chloride 0.2% and Tebuconazole 0.1%)	51.71	65.38	117.09	0.44
S.Em.±		1.29	1.48	2.45	0.01
CD (p=0.05)		3.84	4.40	7.27	0.02

3.3. Nutrient Content

3.3.1. Nitrogen content in grain and straw

The presented data revealed (Table-2) that the nitrogen content in both grain and straw of wheat was non-significantly influenced by the application of different doses of fertilizers and growth regulators. However, maximum nitrogen content in grain and straw was recorded in control. The range of nitrogen content in grain was found 1.644 % to 1.704 %. Maximum nitrogen content was obtained in treatment T_1 (1.704 %) while minimum in treatment T_7 (1.644 %). Similarly Nitrogen content in straw was found maximum in treatment T_1 (0.745%) and minimum in treatment T_7 (0.673 %).

3.3.2. Phosphorus content in grain and straw

The presented data (Table-2) indicates that different levels of nitrogen fertilizer along with growth regulators did not influence the phosphorus content in grain as well as in straw of wheat significantly. Higher amount of phosphorus content in grain and straw was observed in with Control and lowest (0.336%) in $T_{6.}$

3.3.3. Potassium content in grain and straw

The data indicate (Table-2) that different doses of nitrogen fertilizer and growth regulators were found ineffective to influence the potassium content significantly in grain and straw of wheat. K content in grain was recorded maximum in control (0.429%) whereas minimum content of potassium was recorded in treatment T_5 (0.354%). Similarly, potassium content in straw was recorded maximum in control (1.437%) and minimum in treatment T_5 (1.377%).

Thus, plant growth regulators had no discernible effect on the available nitrogen, phosphorus, and potassium concentration in soil after harvest. Although the similar pattern ofeffectofdifferent treatment doses ofnitrogenandgrowthregulatorsongrainandstrawwasobserved,where,significantly maximumNPKuptakewasattributedtocropresponseofgenerating highergrainyieldandbiomassin thetreatments which ultimately contributed to higher total uptakebywheatplant. [16] alsoreportedthe similarkindoffindings. [1] refuted these results, suggesting that the increased nitrogen uptake was likely due to improved soil conditions, which enhanced root growth and plant nutrient demand, allowing the plants to access nutrients from a larger area and greater depth. Among the various spray treatments, the highest NPK uptake was observed with 150% of the recommended NPK doses combined with growth regulators. The impact of growth retardants on wheat growth, biochemical composition, yield, and its components showed that applying Cycocel and Folicur resulted in better root growth, higher nutrient uptake, and increased protein content compared to the control.

Table:-2. Effects of Nitrogen doses and plant growth regulators on N, P and K content in grain and straw of wheat.

Treatment		Nutrient content (%)					
		Nitrogen		Phosphorus		Potassium	
		Grain	Straw	Grain	Straw	Grain	Straw
T_1	Control	1.704	0.745	0.356	0.155	0.429	1.437
T_2	50% RDF of N	1.694	0.721	0.354	0.154	0.415	1.430
T_3	75% RDF of N	1.688	0.711	0.351	0.151	0.401	1.411
T_4	100% RDF of N	1.666	0.709	0.344	0.146	0.389	1.406
T_5	125% RDF of N	1.665	0.695	0.336	0.139	0.354	1.377
T_6	150% RDF of N	1.658	0.692	0.334	0.136	0.355	1.381
T_7	100% RDF of NPK	1.644	0.673	0.352	0.151	0.410	1.413
T_8	125% RDF of N with PGR (Chlormequat chloride 0.2% and Tebuconazole 0.1%)	1.655	0.699	0.340	0.138	0.366	1.382
T_9	150% RDF of N with PGR (Chlormequat chloride 0.2% and Tebuconazole 0.1%)	1.654	0.706	0.337	0.136	0.361	1.385
T_{10}	150% RDF of NPK with PGR (Chlormequat chloride 0.2% and Tebuconazole 0.1%)	1.649	0.698	0.347	0.146	0.418	1.424
S.Em.±		0.01	0.01	0.01	0.005	0.02	0.02

CD (p=0.05)	NS	NS	NS	NS	NS	NS

3.4. Nutrient Uptake

3.4.1. Nitrogen uptake by grain and straw

The study of nutrient uptake by grain and straw of wheat revealed significant difference (fig-2) among the different doses of nitrogen fertilizer and growth regulators. The higher uptake of nitrogen had observed by grain as compared to straw with the application of 150% recommended doses of fertilizer NPK and growth regulator followed by 100% recommended doses of fertilizer of NPK. Significantly higher uptake of nitrogen by grain, straw and total uptake was obtained with the treatment 150% RDF of NPK and growth regulator. Significantly the minimum value of nitrogen uptake was recorded in treatment where fertilizer was not added.

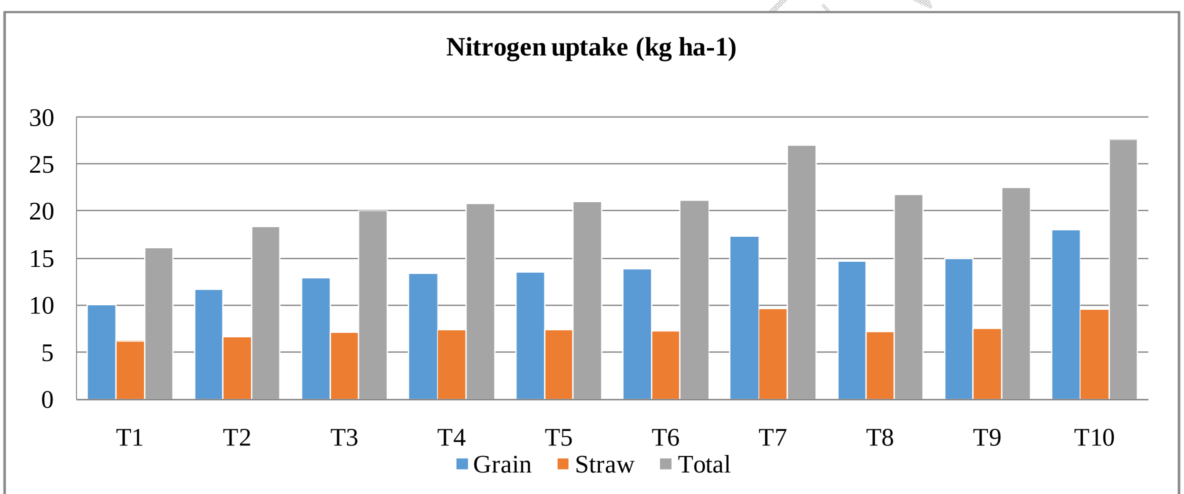

Fig-2-Effect of nitrogen doses and plant growth regulators on nitrogen uptake (kg ha^{-1}) by grain and straw of wheat

3.4.2. Phosphorus uptake by grain and straw

The (fig-3) related to phosphorus uptake under the various level of nitrogen fertilizer and growth regulators revealed that phosphorus uptake by grain was maximum with application of 150% recommended dose of fertilizer NPK and growth regulator which was significantly higher than other treatments and significantly lower value was observed in control. Similar to the grain, in case of straw also maximum amount of phosphorus uptake was found with treatment of 150% RDF of NPK with growth regulator and total uptake also followed the similar trend of phosphorus uptake. While minimum amount of phosphorus was recorded in control treatment where no fertilizers were added.

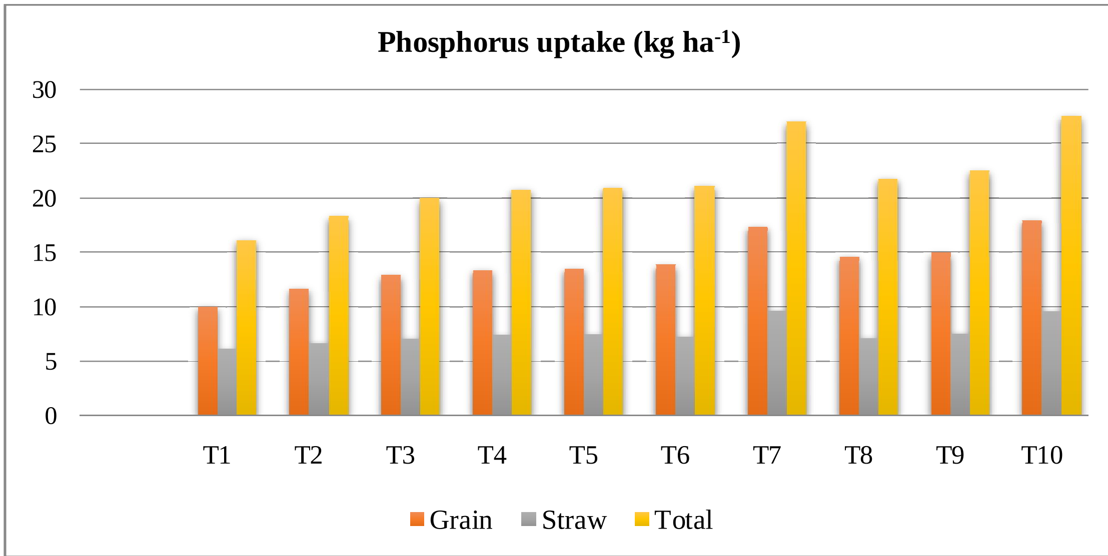

Fig-3-Effect of nitrogen doses and plant growth regulators on phosphorus uptake (kg ha^{-1}) by grain and straw of wheat

3.4.3. Potassium uptake by grain and straw

The data revealed (fig-4) that potassium content in both grain and straw was significantly influenced by the application of different doses of fertilizers. Significantly the highest value of potassium uptake was gained by grain, straw and total with the treatment of 150% RDF of NPK with growth regulator followed by treatment with 100% RDF of NPK, while lowest value of potassium uptake was recorded in control.

Treatments with increased nitrogen uptake were due to improved timing and distribution of nitrogen fertilizer applications throughout the season, which resulted in increased and uniform total nitrogen availability throughout the growing season, increased biomass, and increased accumulation of nitrogen, phosphorus, and potassium in the plants. Nutrient uptake generally follows a yield model. Essential nutrients are involved in plant metabolism, so the amount of nutrient absorbed per unit volume of biomass production determines yield. The increase in phosphorus absorption was due to the significant increase in phosphorus that can be accessed on the soil. This is due to the highest accessibility of a higher dose, and deep penetration should contribute to the absorption of more nutrients in the root sphere. The absorption of potassium wheat has increased significantly compared to the maximum accessories of potassium for plant absorption. The low content and absorption of N, P, and K were observed under absolute control of insufficient supply and nutrients. Similar results were reported by [17], [18], [19]. [20] also reported that nitrogen application increases soil N content and provides sufficient nutrients to the aboveground part of the plant, thus promoting N uptake in winter wheat.

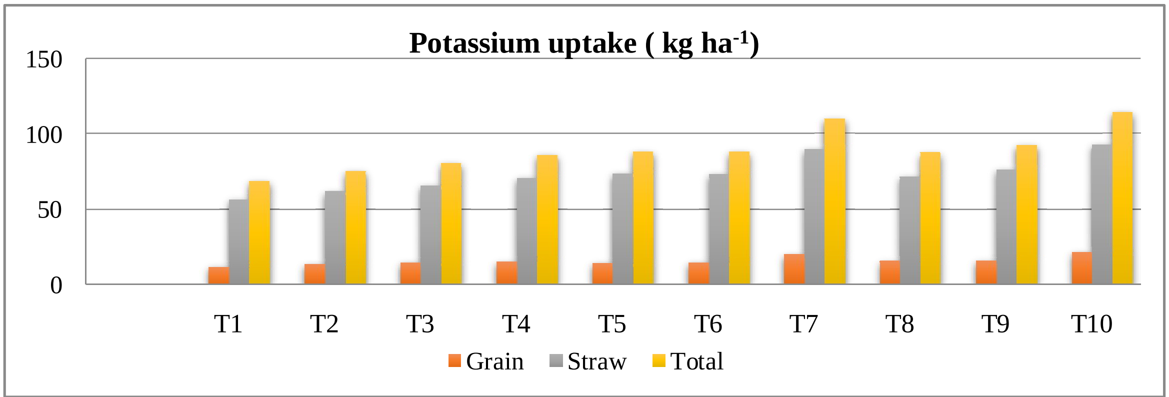

Fig-4-Effect of nitrogen doses and plant growth regulators on potassium uptake (kg ha^{-1}) by grain and straw of wheat

3.5. Soil Analysis

3.5.1. Available nitrogen

Data revealed (Table-3) that the significant effect of fertilizer doses on the available nitrogen content of the soil after the harvest of wheat crop showed significant highest available nitrogen content with the 150% recommended doses of NPK treatment followed by 150% recommended doses of nitrogen fertilizer with growth regulator. Significantly the minimum value of available nitrogen was observed in the treatment in which no fertilizer was applied. The differences in available nitrogen content in soil after the harvest of wheat were due to different quantities of nitrogen applied in soil.

3.5.2 Available phosphorus

The presented data revealed (Table-3) that available phosphorus status in the soil after the harvest of wheat was significantly influenced by various levels of nitrogen fertilizer and growth regulators. The higher value of available phosphorus was found in treatment with 150% recommended dose of NPK with growth regulator followed by 100% recommended dose of NPK and control in that order, each treatment differ significantly from one another. The variations in the available phosphorus content of soil were a result of the varying concentrations of phosphorus that were incorporated into the soil.

3.5.3 Available potassium

The available potassium content (Table-3) in soil recorded after the harvest of wheat crop was also influenced significantly by various levels of nitrogen fertilizer and plant growth regulators. Significantly highest value was recorded with the application of 150% recommended doses of NPK with growth regulator followed by 100% recommended doses of NPK. Significantly minimum value available potassium content was recorded in 150% of recommended doses of nitrogen. The difference were due to the difference quantities of potassium applied to soil, its uptake in different treatments and its subject to losses. Thus it was concluded that no significant effect of growth regulators on available nitrogen, phosphorus and potassium content in soil after the harvest of wheat crop. Similar observations were recorded [21] their finding suggested that significantly higher value of available NPK in soil when the wheat crop was fertilized with the higher doses of fertilizer (120:60:60) as compared to other doses.

Table:3.Effect of nitrogen doses and plant growth regulators on the nutrient status of soil after the harvest of wheat.

Treatment		Available nutrient in soil (kg ha^{-1})		
		Nitrogen	Phosphorus	Potassium
T_1	Control	138.81	22.43	175.41
T_2	50% RDF of N	145.20	22.36	175.00
T_3	75% RDF of N	150.01	23.29	177.22
T_4	100% RDF of N	156.52	22.11	176.44
T_5	125% RDF of N	162.67	22.24	177.02
T_6	150% RDF of N	167.16	23.50	174.04
T_7	100% RDF of NPK	157.38	25.87	187.17
T_8	125% RDF of N with PGR (Chlormequat chloride 0.2% and Tebuconazole 0.1%)	164.34	22.25	176.28
T_9	150% RDF of N with PGR (Chlormequat chloride 0.2% and Tebuconazole 0.1%)	169.16	22.38	175.22
T_{10}	150% RDF of NPK with PGR (Chlormequat chloride 0.2% and Tebuconazole 0.1%)	171.82	27.01	192.27
S.Em.±		3.7	0.53	1.73
CD (p=0.05)		11.08	1.58	5.13

Growth regulators: Chlormequat chloride 0.2% and Tebuconazole 0.1%

4. Conclusion

Nitrogen one of the most important nutrients required for crops growth and development and it influence wheat significantly in growth, yield and nutrients uptake by wheat plants. Increasing levels of nitrogen increased wheat growth characteristics, yield characteristics such as grain yield (kg/ha), straw yield (kg/ha), biological index (kg/ha) and harvesting index and nutrients uptake i.e. nitrogen uptake in seed and straw, phosphorus uptake in seed and straw and potassium uptake in seed and straw. It was found that maximum uptake of nutrients and maximum amount of available N, P and K (171.82, 27.01 and 192.27 kg ha^{-1}was obserbed in treatment T_{10} (150% RDF of NPK along with chlormequat chloride 0.2% + tebuconazole 0.1%). Nutrient management with growth regulators in wheat, economically viable and ecologically sound option to extend these benefits of balanced nutrition in enhancing both crop production as well as soil fertility.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declares that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

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