Effect of Various Level of Nutrient Application on Yield and Yield Attributing Characters of Wheat at Dehradun, India

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***Abstract*—** *A field experiment was conducted in the Agronomy research farm, Uttaranchal (PG) College of Bio-medical Sciences and Hospital, Dehradun during Rabi season to study effect of different NPK levels on growth and yield of wheat and work out relative economics of different levels of NPK. This field experiment was conducted to investigate the combined effect of different NPK (Nitrogen, Phosphorus and Potash) levels on the growth, yield and yield attributing characters of wheat cultivars PBW373. The thrice replicated treatments (T_1: Control, T_2:25% N_2+50% P_2O_5+ 25% K_2O, T_3:50% N_2+50% P_2O_5+50% K_2O, T_4:75% N_2+50% P_2O_5+50% K_2O, T_5:100% N_2+50% P_2O_5+50% K_2O, T_6:25% N_2+100% P_2O_5+100% K_2O, T_7:50% N_2+100% P_2O_5+100% K_2O, T_8:75% N_2+100% P_2O_5+100% K_2O, T_9:100% N_2+150% P_2O_5+150% K_2O RDF) ha^{-1} were tested in Randomized Complete Block Design (RCBD). The results revealed that the highest growth, yield and yield attributing characters replied significantly to NPK fertilizers but access (higher dose than 100%) of Phosphorus and Potash shows negative results. It is resulted that highest growth was recorded with the treatment T_5:100% N_2+50% P_2O_5+50% K_2O or application of (120-30-30) NPK Kg ha^{-1} and lowest conclude treatment combination was T_1 (no fertilizer application). The highest days to maturity was recorded from treatment T_5 while the lowest days to maturity was observed from treatment T_1. Application of different NPK Levels on economics of wheat showed varied trend in benefit: cost ratio (B: C ratio). The maximum B: C ratio was obtained with treatment T_2, while further increase in fertility levels obtained less B: C ratio followed by lowest rate of nutrient. The highest net return was obtained in the treatment T_5 followed by treatment T_2 and T_3 respectively. It was due to the significantly higher grain and straw yield on treatment T_5 crop than the other treatments, which resulted in higher net return and benefit cost: ratio. So it is concluded that the treatment T_5 (100% N_2+50% P_2O_5+50% K_2O) shows best results on wheat crop and proved to the most remunerative dose. This study will enhance the nutrient use efficiency and fetch high and quality production of wheat in less cost of production without causing adverse effect on environment.*

Keywords*— *Fertilizer, Growth, Nutrients, Soil fertility, wheat, Yield.

I. INTRODUCTION

Wheat (*Triticum aestivum* L.) is the major staple food crop of the world. It is used as a staple food by about 10 million peoples all over the world mainly in the 43 countries and contributes 30% to overall grain demand of the world. It provides around 20% of the aggregate food calories to mankind (Redddy, 2004) having maximum protein as compared to other cereals. In India, wheat is cultivated over an area of 28.17 million hectare with a production and productivity of 73.70 Mt and 26.17 qha^{-1}, respectively (Anonymous, 2007). It contributes 35% of the total food grain production of the country. India alone produces 13% of world's wheat (Anonymous, 2007).

There are many factors responsible for low yield of wheat including improper application of nitrogen fertilizer or no application of nitrogen fertilizer, edaphic properties, biotic properties, availability and distribution of irrigation, prevailing climatic conditions, improper field management and lack of adequate farmer's knowledge and awareness. Firstly nitrogen is one of the major nutrients which play important role for metabolic process of the plant for bumper yield when it applied in appropriate amount. All the biochemical process occurring in the plants are mainly governed by nitrogen and its associated compounds, which make it essential for growth and development of wheat (Kutman et al., 2011). Therefore it is necessary to apply nitrogen fertilizer in the soil to get bumper yield of wheat (Ali et al., 2000). Secondly phosphorus play vital role for plant development starting as wheat is just a seedling and continuing all the way to maturity. Apart from formation of quality seeds, this nutrient ensures uniform heading, faster maturity and strengthens the plant to survive during the winter. The most noticeable symptoms are stunted growth, stems and leaves turn purple, reduced root system and poor tillering are common symptoms when deficiencies are observed, winter wheat is more susceptible to winterkill and vulnerable to disease pressure, among other plant health issues and finally wheat requires potassium for optimum growth and development. Adequate potassium results in superior quality of whole plants due to improved efficiency of photosynthesis, increased resistance and greater water use efficiency and sufficient potassium results in stronger wheat straw and assists in grain filling.

Nitrogen is the most important element to achieve stable high grain yields and growth it is essential for improving grain quality of wheat. In order to get high yield and good and stable quality of wheat N fertilizer rates, split N application and timing of application have been the major strategies recommended to increased protein content and improved oleograph parameters (Shejbaloval et al., 2014). Phosphorus is the second to nitrogen as the nutrient that most commonly limits wheat growth and development. Phosphorus has been the subject of more fertility investigation than any of the other essential elements. Soil phosphorus (P) deficiency is a major constraint to increased crop yields in many areas of the world (Vance et al., 2003). The production of less photosynthetic assimilates and reduced assimilate transport out of the leaves to the developing fruit greatly contributes to the negative consequences that deficiencies of potassium have on yield and quality production (William, 2008). Saini et al (2010) reported that recommended dose of fertilizer may have supplied nutrients to crop in optimum and balanced proportion required for its better growth and development, thereby leading to higher grain yield. The combined application of N, P and K has proved to be more effective in increasing yield of wheat as compared to sole application of either N or P or K (Petkov, 1983).

Application of imbalanced or excessive nutrients led to declining nutrient use efficiency and making fertilizer consumption uneconomical and producing adverse effects on atmosphere and ground water quality causing health hazards and climate change (Aulakh et al., 2009). Keeping this in view the present experiment was conducted with the following objectives:

- To study the effect of different NPK levels on growth and yield of wheat under normal practice and system of wheat intensification.
- To study the effect of different nutrient levels on flowering and maturity of wheat crop.
- To work out relative economics of different levels of NPK.

II. MATERIALS AND METHODS

2.1 Experimental site

The present study entitled "Effect of Various Level of Nutrient Application on Yield and Yield Attributing Characters of Wheat" was carried out at the Agronomy Research Farm of Uttaranchal (PG) College of Bio-medical Sciences and Hospital, Turner Road, Dehradun during rabi season of the year 2019-20. It is situated 30 masl and lies between the evoba retem 674 30 eht neewteb seil hcihw level aes naem^{0}31'40" N latitude and 78^{0}03'05" E longitude and Plots of homogenous fertility were selected from the field and well connected with irrigation channel for timely use. The details of the materials used and method employed are described as under:

2.2 Climatic Condition of the Area

The experimental site had a warm and temperate climate with a hot and dry summer, cold winter and mild to heavy rains. The average annual temperature of the area is 21.8^{0}C with an annual rainfall of 1896 mm. The soil was clay loam in texture, and of medium fertility with slightly alkaline in reaction. It was poor in organic carbon with low to medium in fertility status.

2.3 Land Preparation

Proper field preparation is essential for good germination and growth of the wheat with to have a suitable field for sowing. The experimental field was ploughed, dry weeds and stubbles were removed. The field was again ploughed by cultivator and finally planking was done to obtain a good tilth. The block borders, plot bunds and irrigation channels were made manually as per the layout plan. The experimental plots were leveled before sowing of seeds.

Nutrient application was done as per treatment. In main plots, half of the total quantity of nitrogen along with the full dose of phosphorus, potassium were applied just before sowing and incorporated into the top 15 cm soil manually with the help of spade. The remaining half quantity of N through urea fertilizer was top dressed in two equal installments 25 and 48 DAS. Sowing was accomplished with Row to Row distance of 20 cm.

2.4 Experimental Detail

The present study was design to evaluate the effect of different level of fertilizer on wheat yield and yield attributing characters. The variety used was PBW373. The experiment was laid down as per randomized complete block design (RCBD) with three replications, each replication with nine treatments. Field border and plot border were left to minimize outside effect. The irrigation channels were placed at suitable location for facilitating the irrigation. Five representative plants per treatment per replication were used for data recording. The details of layout were as follows:

TABLE 1
LAYOUT OF THE MAIN PLOT

Details	Value
Plot size	864F2
Border between plots	0.5 m
Border between replications	0.5 m
Gross experimental areas	864F2
Total no of plot	27
Size of mini plot	8*8(feet)

2.4.1 Treatments

T_1= Control

T_2 = 25% N_2+50%P_2O_5+ 25%K_2O

T_3 = 50%N_2+50%P_2O_5+50%K_2O

T_4 = 75%N_2+50%P_2O_5+50%K_2O

T_5 = 100%N_2+50%P_2O_5+50%K_2O

T_6 = 25%N_2+100%P_2O_5+100%K_2O

T_7 = 50%N_2+100%P_2O_5+100%K_2O

T_8 = 75%N_2+100%P_2O_5+100%K_2O

T_9 = 100%N_2+150%P_2O_5+150%K_2O

2.4.2 Fertilizer Material and Observations

Fertilizer materials:

- Urea
- Diammonium phosphate (DAP)
- Single super phosphate(SSP)
- Muriate of potash (MoP)

TABLE 2
DETAILS OF FIELD OPERATION PERFORMED DURING WHEAT CULTIVATION IN THE YEAR 2019-20.

S. No.	Operation performed	Date of Operation
1.	Preparatory tillage	
	Pre irrigation	20/11/2019
	Ploughing	21/11/2019
	Harrowing & planking	22/11/2019
2.	Layout and sowing	23/11/2019
3.	Fertilizer Application	23/11/2019
	Basal Application of NPK	18/12/2019
	Top Dressing of N (1/3)	10/01/2020
4.	Irrigation	15/12/2019
		07/01/2020
		31/01/2020
5.	Weeding	10/03/2020
	Ist	16/12/2019
	IInd	8/01/2020
6.	Harvesting	15/04/2020
7.	Threshing and winnowing	20/04/2020

2.5 Soil and Soil Analysis

Soil as a medium of plant growth is affecting the plant growth and ultimately the final yield through its properties. Therefore, an attempt was made to assess the physical and chemical properties of soil of the experimental field. To evaluate the soil fertility samples were collected from the experimental field before sowing of the crop. Soil samples were taken randomly from the different parts of the field upto a depth of 0-20 cm and a composite sample was prepared which was used for further analysis. Sample was analyzed in the Soil Testing Laboratory of Doon University, Dehradun with following methods. The results thus obtained are presented in the table 3.

TABLE 3
PHYSICAL AND CHEMICAL PROPERTIES OF THE SOIL

Particulars	Value	Rating	Method	Reference
Mechanical Analysis				
Sand (%)	19.81	Silt loam	Hydrometer	Bouyoucos (1962)
Silt(%)	40.20			
Clay(%)	39.99			
Textured class			Soil texture triangle	Black et al. (1965)
Physical constants				
Bulk density (Mg m-3)	1.5		Core sampler	Black et al. (1965)
Chemical Analysis				
Organic carbon (%)	0.25	Low	Wet digestion method	Wankley and Blacks (1934)
Available N (Kg ha^{-1})	202	Low	Alkaline potassium permagnate	Subbiah & Asija (1956)
Available P_2O_5 (Kg ha^{-1})	20	medium	0.5 MNaHCO3 extractable	Olsen et al. (1954)
Available K_2O (Kg ha^{-1})	180	medium	Flame photometer method	Jacksom (1973)
pH (1:2.5 soil: water suspension)	7.6	Alkaline	Glass electrode digital pH meter	Sparks (1996)
Electrical conductivity (1:2.0 soil: water suspension)	0.28	Normal	Systronics electrical conductivity meter	Sparks (1996)

It is evident from soil analysis that the soil of the experimental field was silty loam with moderate fertility status having low in available organic carbon, nitrogen and medium in phosphorus and potassium.

2.6 Observation recorded

All the yield and yield attributing parameters were recorded at regular interval as per the standard procedures and they were analyzed as per the analysis of variance (ANOVA) technique and the critical differences between the treatments were worked at 0.05 probability. The economics were worked out using the prevailing market prices for both inputs and outputs.

2.6.1 Plant height

The height of five plants was measured in cm from ground level up to the height levels reached by the leaves and the average height per plant was calculated. The observations were taken at 30, 60, and 90 and at harvest and then averaged.

2.6.2 Number of tillers per square meter

Tillers were counted in one meter row length at three different places in each sub plot and were converted into tillers m^{-2}.

2.6.3 Number of leaves per plant

Number of leaves was counted in each selected plant per plot and the average value was calculated.

2.6.4 Number of spikes per plant

In field experiment the number of spikes were counted from five plants selected randomly form each treatment and then the average was calculated.

2.6.5 Spike length (cm)

Spike length was measured with a measuring tape from peduncle node to the tip of the spike. Three plants per plot were selected for recording spike length and mean was calculated.

2.6.6 Number of grain per spike

Three spikes were taken from each treatment. Threshed and the number of grains counted, and the mean grain per spike calculated.

2.6.7 1000 Grain weight (g)

Ten random samples of 1000 grains each were weighted using electronic balance to calculate 1000 grain weight.

2.6.8 Biomass yield (Straw yield) per unit area

Harvested crop which included grain+ stem+ leaves were weighed after drying in the sun to record biological yield in each plot.

2.6.9 Grain yield kg/ha

After threshing and cleaning, all grains were harvested to record grain yield per plot. Then converted it into grain yield kg/ha by using the formula.

$$Grain\ yield\ kg/ha\ (Actual) = \frac{Total\ grain\ wt.(kg)}{Size\ of\ the\ area\ (m)^2} X\ 10{,}000\ m^2 \quad (1)$$

$$Grain\ yield\ \frac{kg}{ha}\ (Calculated) = \frac{Spikes\ /m^2\ X\ grain\ /spike\ X\ 1000\ grains\ wt.(g)}{1000\ X1000} X10{,}000\ m^2 \quad (2)$$

2.6.10 Harvest index

Harvest index is the ratio of the economic yield to the biological yield produced. It was calculated by the formula of Singh and Stoskoff (1971).

$$Harvest\ index\ (\%) = \frac{Economic\ yield}{Biological\ yield} X\ 100 \quad (3)$$

2.7 Soil Parameters

Soil sample were collected from 0-20 cm depth at the beginning of experiment to know the available NPK, pH and EC status during the course of investigation. Available nitrogen, phosphorus, potassium, pH and electrical conductivity were determined as per method given in Table 3. Composite soil samples were collected from 0-20 cm depth before starting of the experiment. The soil samples were analyzed chemically for various characters.

2.7.1 Organic carbon

The organic carbon was determined by Walkley and Black's wet oxidation method, as described by Jackson (1973). It was expressed in percentage.

2.7.2 Available nitrogen

It was estimated by alkaline permanganate method as outlined by Subbiah and Asija (1956). It was expressed in kg ha^{-1}.

2.7.3 Available phosphorus

Available phosphorus content of soil was determined by Olsen's method as described by Olsen et al. (1954). It was expressed in kg ha^{-1}.

2.7.4 Available potassium

Available potassium was determined by flame photometer after extracting the soil with neutral normal ammonium acetate as described by Jackson (1973). It was expressed in kg ha^{-1}.

2.8 Economics

The economics of various treatments was calculated by taking into account the existing price of the input and produce. The investment on fertilizers, labour and power for performing different operations such as ploughing, irrigation etc. were worked out. The cost of cultivation was taken for calculating economics of treatments and expressed as net return (Rs. ha^{-1}) and benefit cost ratio.

2.8.1 Gross income (ha^{-1})

The yield of wheat crop was converted into gross income in ha^{-1} on the basis of current price of the produce.

2.8.2 Net return (ha^{-1})

The net return was worked out by using following formula

$$\text{Net return } (ha^{-1}) = \text{Gross income } (ha^{-1}) - \text{cost of cultivation } (ha^{-1}) \quad (4)$$

2.8.3 Benefit: cost ratio

The benefit cost ratio was worked out on the basis of net return per unit cost of cultivation (Rs. ha^{-1})

$$Benefit\ cost\ ratio = \frac{Net\ return\ \ (ha^{-1})}{Cost\ of cultivation\ \ (ha^{-1})} \quad (5)$$

III. RESULTS AND DISCUSSIONS

3.1 Growth Parameters and Yield attributes

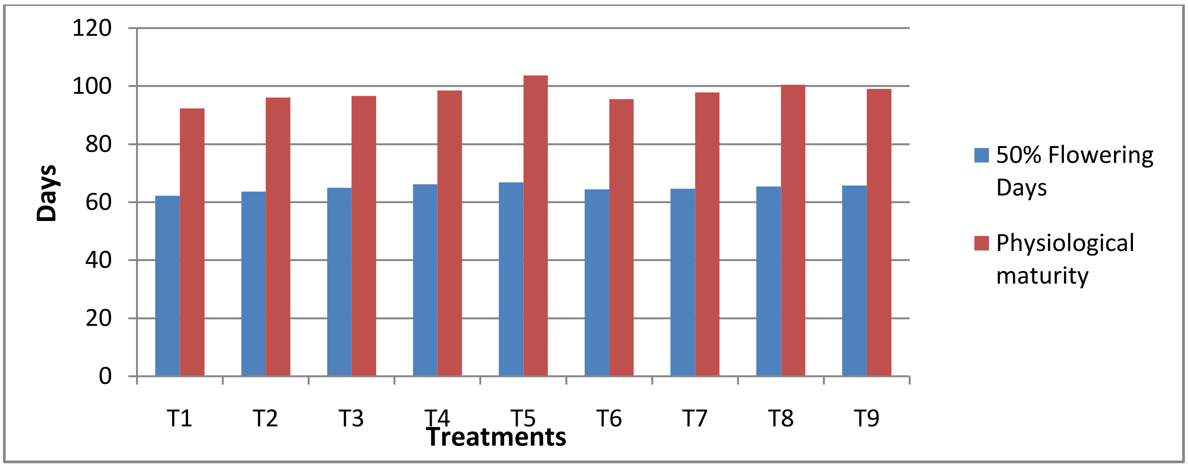

FIGURE 1: Effect of different NPK levels on Phenological characters of wheat.

Days to 50% flowering of wheat showed statistically significant variation due to different levels of NPK. The highest days to flowering (66.81) was recorded from treatment T_5. 53.50 followed by T_4 66.170, T_9 65.73. The lowest days to flowering (62.19) were observed from T_1 (Control). The result of the study revealed that no application of NPK tends to early flowering.

Statistically significant variation was recorded in terms of days to maturity of wheat due to different amount of NPK. The highest days to maturity (103.66) was recorded from T_5 while the lowest days to maturity (92.29) was observed from T_1 (Control). But Atikulla (2013) reported that low level of nutrient hastened the maturity period of wheat.

3.1.1 Effect of NPK level on plant height

Plant height was measured thrice at different days interval (30, 60, 90 and at harvest) and the results revealed that plant height was significantly affected by different treatments. The data present in Table 4 revealed that shoot elongation continued to increase with the advancement in age of the plants and a rapid increase in plant height was noticed up to 90 DAS and thereafter it increased slowly. An examination of data show significant effect of different nutrient (NPK) levels on plant height. Plant height under different treatments varied from 18.02 to 23.67 cm at 30 DAS, 44.56 to 57.57 cm at 60 DAS, 83.09 to 101.61cm at 90 DAS and 84.01 to 102.06 cm at harvest.

Data in table 4 reveals that the observation on plant height at different stages of growth 30, 60, 90 DAS and at harvest that treatment combinations T_5 (N100% P50%, K50%) results is greater increase in height (23.67, 57.57, 101.61 and 102.06) cm respectively in successive stage of growth.

At 30 DAS, the treatment combination T_5 (N100%, P50%, K50% RDF) shows significant increase in height that is 23.67 cm in comparison to other treatments. The minimum plant height was recorded in the treatment T_1 (control) that is 18.02 cm.

At 60 DAS, the treatment combination T_5 (N100%, P50%, K50% RDF) shows a significant increase in height that is 57.57 cm in comparison to other treatments. The minimum plant height was recorded in the treatment T_1 (control) that is 44.56 cm.

At 90 DAS, the treatment combination T_5 (N100%, P50%, K50% RDF) shows significant increase in height that is 101.61 cm in comparison to other treatments. The minimum plant height was recorded in treatment combinations T_1 (control) that is 83.09 cm.

At harvest, the treatment combination T_5 (N100%, P50%, K50% RDF) shows significant increase in height that is 102.06 cm in comparison to other treatments and minimum height was recorded in treatment combination T_1 (control) that is 84.01 cm. It was observed as the level of nitrogen increased plant height was also gradually increased. Similar increase in plant height, number of tillers m^{-2} and dry matter accumulation of wheat by increase in nutrients level were also noted by Hameeda et al. (2010) and Jat et al. (2013).

TABLE 4
EFFECTS OF DIFFERENT LEVELS OF NITROGEN, PHOSPHORUS AND POTASSIUM ON PLANT HEIGHT OF WHEAT (*TRITICUM AESTIVUM L*).

Treatment	Plant Height in Cm (Mean± S.E.)			
	30 DAS	60 DAS	90 DAS	At harvest
T_1	18.02± 0.02	44.56± 1.27	83.09± 0.15	84.01± 0.60
T_2	18.81± 1.11	47.81± 0.18	85.64± 1.51	87.35± 1.01
T_3	19.47± 0.30	49.07± 0.48	87.79± 0.78	89.22± 0.45
T_4	20.68± 0.34	52.44± 0.34	90.52± 0.29	91.59± 0.38
T_5	23.67± 0.35	57.57± 1.22	101.61± 0.88	102.06± 1.11
T_6	19.72± 1.36	45.51± 1.75	84.01± 1.24	85.21± 0.87
T_7	19.47± 0.52	47.09± 1.27	87.24± 1.34	88.12± 1.81
$\mathbf{T_8}$	18.66± 1.06	46.71± 1.35	87.25± 1.67	88.11± 1.45
T_9	18.41± 0.65	48.99± 1.27	84.39± 2.22	85.57± 2.13
C.D.	2.299	3.519	3.881	3.771
SE(m)	0.76	1.164	1.284	1.247
SE(d)	1.075	1.646	1.815	1.764
C.V.	6.698	4.125	2.528	2.427

CD (P=0.05)

3.1.2 Effect of different NPK levels on number of leaves, tillers, spike length, grain per spike and Test Weight of wheat.

The number of leaves per plant was significantly influenced by different levels of nutrient application. Assessment of data indicated that number of leaves per plant firstly increased up to 60 DAS after that it decreased. A reference of data presented in Table 5 shows the number of leaves per plant. A significant increase in number of leaves on account of treatment T_5 was observed. The reduction of leaves was found maximum in control. It is evident from the statistical analysis that it was maximum in treatment T_5 (40.39) and minimum in control (32.22) at the time of harvest. There was a significant difference in number of leaf per plant under different treatments. The data revealed that significant effect of NPK levels on effective tillers m^{-2}. It is clearly evident from the data that increasing levels of NPK increased the effective tillers m^{-2}. The maximum effective tillers m^{-2} were recorded with the treatment T_5 (336.33), whereas minimum value was recorded with treatment T_1 (Control) which was 324.33. Data has given in the Table 5 reveals that the average number of tillers per plant at successive stage of growth under various treatment combinations. Data on number of tillers m^{-2} revealed that the treatment combination T_5 i.e. 336.33 m^{-2} resulted in maximum number of tillers m^{-2} and the minimum number of tillers m^{-2} observed in treatment combinations T_1 (control) i.e.324.33 m^{-2}. Similar results have been reported by Ramakrishna et al., (2007).

Data on spike length are presented in Table 5 Scanning of the data revealed that the variation in spike length due to different NPK levels was not significant. The result of the analysis shows different level of NPK has no effect on spike length. The higher length of spike was recorded with treatment T_5i.e. 11.13 cm. The data pertaining to grains spike^{-1} as affected by different treatments are presented in Table 5. Analysis of the data clearly revealed that significant variation on grains spike^{-1} due to different NPK levels. An examination of the data revealed that a significant increase in grains spike^{-1} was observed with graded level of NPK. The highest grains spike^{-1} were observed with the treatment T_5 and followed by treatment T_4 which was 36.07 and 33.80, respectively. The minimum grains spike^{-1} was observed with the treatment T_1 (control) i.e. 25.47. Data pertaining to 1000-grain weight (test weight) as influenced by different treatments are summarized in Table 5. The analysis of data shows significant effect of NPK levels on 1000-grain weight. It was clearly found from the data that increase in NPK levels increased the 1000-grain weight. The maximum 1000-grain weight was found with treatment T_5 i.e. 36.03 g whereas the minimum value was recorded with T_1 (Control) i.e. 29.15 g. The percent increase in 1000-grain weight under T_5 over T_1 was 23.7. These findings are in close agreement with those of Jat et al., (2013) and Patel et al., (1995).

TABLE 5
EFFECT OF DIFFERENT NPK LEVELS ON YIELD ATTRIBUTES OF WHEAT.

Treatments	At Harvest				
	Number of leaves per plant	No of tillers m^{-2}	Spike length (Cm)	Grains per spike	1000 Grain weight(g)
	(Mean± S.E)	(Mean ±S.E)	Mean± S.E.	Mean± S.E.	Mean± S.E.
T_1	32.22± 1.807	324.33± 2.333	10.43± 0.35	25.47± 0.41	29.15± 0.52
T_2	34.61± 0.808	326± 1	9.67± 0.39	31.4± 0.35	30.84± 0.03
T_3	35.97± 0.525	329.67± 1.20	9.22± 0.67	32± 0.42	31.76± 0.24
T_4	37.40± 0.776	333.33± 0.88	10.14± 0.24	33.8± 0.35	32.91± 0.53
T_5	40.39± 0.335	336.33± 0.88	11.13± 0.24	36.07± 0.47	36.03± 0.48
T_6	36.12± 0.239	326.67± 0.88	9.64± 0.54	27.13± 2.56	30.81± 0.41
T_7	36.41± 0.599	327.67± 1.45	9.68± 0.24	30.67± 0.37	31.65± 0.33
T_8	37.24± 0.828	331.33± 0.33	9.56± 0.36	31.89± 0.52	32.76± 0.24
T_9	39.07± 0.636	325.67± 2.33	10.27± 0.40	30.82± 0.52	30.8± 0
C.D.	2.506	3.849	N/A	2.671	1.244
SE(m)	0.829	1.273	0.398	0.883	0.411
SE(d)	1.172	1.8	0.564	1.249	0.582
C.V.	3.922	0.67	6.921	4.93	2.237

CD (P=0.05)

3.1.3 Effect of different NPK levels on grain and straw yield and harvest index of wheat.

The data pertaining to grain yield of wheat as influenced by NPK levels have been presented in Table 6, Data shows that the highest grain yield was recorded with treatment T_5 (3,176kg ha^{-1}) and it's gave 20.7 per cent higher grain yield over treatment T_1 control (2,630 kg ha^{-1}). Reduction and excessive dose of NPK application decreased the grain yield significantly. It is supported by (Kachroo and Razdan, 2006; Jat et al., 2013).

The data pertaining to straw yield of wheat as influenced by NPK levels has been presented in Table 6. The data revealed that biological yield was significantly increased with the increasing NPK levels and also decreased with the excess of the NPK level. The maximum biological yield was recorded with treatment T_5 (5,248.67 kg ha^{-1}) which was significantly superior over the lowest fertility recorded minimum biological yield of 4,291.33 kg ha^{-1}. The magnitude of increase in biological yield under treatment T_5 over treatment T_1 (control) was 18.24.

The data on harvest index pertaining to various treatments are presented in Table 6. A perusal of data clearly indicated that the NPK levels were influenced significantly on harvest index of wheat. It revealed from the data that harvest index significantly increased with increase in fertility levels. Maximum harvest index was recorded under treatment T_5 (42.03%) and minimum harvest index was recorded with treatment T_1 i.e. control (36.03 %).

TABLE 6
EFFECT OF DIFFERENT NPK LEVELS ON GRAIN AND STRAW YIELD AND HARVEST INDEX OF WHEAT.

Treatment	Grain yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest Index
	Mean± S.E.	Mean	Mean
T_1	2,630± 83.35	4,291.33± 35.17	36.03± 0.35
T_2	2,795± 6.56	4,559.67± 73.64	37.03± 0.89
T_3	2,798.67± 1.79	4,709.33± 60.12	37.47± 0.58
T_4	2,818± 68.72	4,805.33± 12.42	38.33± 0.38
T_5	3,176± 23.54	5,248.67± 76.17	42.03± 0.87
T_6	2,569.33± 88	4,492.67± 48.53	38.60± 0.79
T_7	2,559.67± 30.82	4,656.33± 77.55	36.43± 0.35
T_8	2,623.33± 63.62	4,711.67± 157.76	37.93± 0.66
T_9	2,633.67± 33.66	4,427.67± 29.19	38± 1.258
C.D.	121.360	236.590	2.000
SE(m)	40.135	78.242	0.661
SE(d)	56.759	110.651	0.935
C.V.	2.543	2.911	3.009

CD (P=0.05)

3.1.4 Effect of different NPK levels on Economics of wheat

Treatment wise cost of cultivation, gross income, net return and benefit : cost ratio have been analyzed and presented in Table 7 which reveals that highest net return (Rs. 79074ha^{-1}) was obtained with treatment T_5 followed by T_3 and T_4 respectively. The maximum but being at par with treatment T_5 (2.41) benefit: cost ratio was recorded when NPK level was treatment T_3 (2.46). The lowest value of benefit: cost ratio was obtained with treatment T_9 (1.89). Similar results have been reported earlier by Singh et al. (2010); Eslami et al. (2014), and Hussain et al. (2015).

TABLE 7
EFFECT OF DIFFERENT NPK LEVELS ON ECONOMICS OF WHEAT

Treatment	Economics (ha^{-1})			B:C ratio
	Gross income	Cost of	Net return	
T_1	92188	27204	64984	2.39
T_2	97962	28298	69664	2.46
T_3	99228	29945	69283	2.31
T_4	100436	31348	69088	2.20
T_5	111856	32782	79074	2.41
T_6	92454	29945	62509	2.09
T_7	93546	30456	63090	2.07
T_8	95394	31873	63521	1.99
T_9	93342	32345	60997	1.89
C.D.	939.546	4.517	4.227	0.111
SE(m)	310.716	1.494	1.398	0.037
SE(d)	439.418	2.113	1.977	0.052
C.V.	0.553	0.008	0.004	2.876

CD (P=0.05)

IV. CONCLUSION

On the basis of growth and yield parameters and economic analysis of different levels of NPK it is concluded that the treatment T_5 ($100\%N_2+50\%P_2O_5+50\%K_2O$) shows best results on wheat crop and proved to the most remunerative dose. This research suggested that the appropriate dose of fertilizer enhances the nutrient use efficiency and get high and quality yield in minimum cost of production without causing adverse effect on environment.

Further study is also required to investigate the effect of micro- nutrient on growth and yield attributing character of wheat. Additional advanced research is needed to explore the effect of macro and micro nutrients in physiological and biochemical attribute of wheat.

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