Effect of Nano DAP on growth and yield performance of *Triticum aestivum*(L.) east nimar region, Khandwa, MP

ABSTRACT

The study was to evaluate the impact of Nano DAP on the growth and productivity of wheat (*Triticum aestivum* L.), specifically on the HI-1634 (Pusha Ahilya) variety, through foliar application. The experiment laid out in randomized block design (RBD) with three replications. The field experiment was carried out during the Rabi season of 2023/24 at the School of Agriculture, Research farm of DR. C.V. Raman University in Khandwa, Madhya Pradesh.There were seven treatments consisting of different doses of T1-100% NPK, T2-75% N and P and 100% K, T3- 50% N and P and 100% K, T4- T2 + ST with Nano DAP @ 5 ml/kg seed + FS with Nano DAP @ 2 ml/litter of water, T5-T3 + ST with Nano DAP @ 5 ml/kg seed + FS with Nano DAP @ 4 ml/liter of water, T6- T2 + ST with Nano DAP @ 5 ml/kg seed + FS with Nano DAP @ 4 ml/litter of water at and T7- Control. The findings revealed that treatmenT1 resulted in the highest number of tillers and yield, followed by T6, which significantly higher performance with the application of 100% NPK. The foliar sprays of Nano-DAP in T1 treatment showed promising outcomes in terms of tillers, grains earhead^{-1}, spikelet earhead^{-1}, earhead^{-1} length, and yield ha^{-1}. It is evident that utilizing Nano DAP in place of half of traditional DAP, as well as treating seeds with Nano DAP, leads to superior root growth and overall crop development.

Keywords: Foliar application,Nano-DAP,Wheat, Yield

Introduction

Wheat (*Triticum aestivum* L.) is a cereal grain that originated in the Levant region but is now grown all over the world (Feldman *et al.*, 2007). Wheat is a grain crop that provides a significant amount of carbohydrate (Shewry and Hey, 2015). It is the most common source of vegetable protein in human meals, with a protein level of around 13%, which is reasonably high when compared to other main cereals but low in protein quality for delivering important amino acids. Wheat is grown on 223.40 million hectares, yielding 778.6 million metric tonnes globally. It is cultivated on 31.62 million hectares in India, with a total yield of 3420 kg per hectare and a total production of 109.2 million metric tonnes (USDA, 2021). Madhya Pradesh produces wheat on 10.02 million hectares, yielding 16.52 million metric tonnes with a productivity of 3298 kg per hectare (Department of Agriculture, M.P., 2021).

The Indian population was 683 million in 1981, but it is expected to increase to 1475 million by 2030. To feed the predicted 1.48 billion people by 2030, India would need to produce 350 million tonnes of food grains. This growing trend indicates that the creation and application of new forms of fertilizers is one of the few viable alternatives for feeding the predicted world population of 9.6 billion in 2050 or more without adversely endangering ecosystems and the environment. The recent surge in global population has compelled the agricultural industry to enhance crop yield in order to feed billions of people, particularly in underdeveloped and emerging nations(Jain *etal.,* 2021).

Materials and methods

Study area

The field experiment on wheat crop was conducted in the research farm of DR. C.V. Raman University Khandwa M.P. The study location comes under tropical and subtropical climate zone and is located at 21°50'N, latitude and 76°13'E longitude and the maximum and minimum height above mean sea level is 905.56 m and 180.00 m respectively.

Experimental details:

Seven Treatments with 3 Replication of Wheat variety- (HI-1634) with Fertilizer dose (RDF)N: P_2O_5: K_2O: 120:60:40 and Statistical design Randomized Block Design (RBD). Plant spacing was used 22.5 cm (Row to Row), Seed rate of wheat seed were used 100 $kgha^{-1}$, Gross plot Size was used 5 m × 5 m and Net Plot Size was 4 m × 4.10 m

Details of treatments:

The seven (7) treatments were used **T1**-100% NPK (120:60:40 kg ha-1 Recommended dose), **T2**-75% N & P and 100% K (90:45:40 kg ha-1), **T3**- 50% N & P and 100% K (60:30:40 kg ha-1), **T4**- T2 + ST with Nano DAP @ 5 ml/kg seed + FS with Nano DAP @ 2 ml/litter of water at 30 DAG , **T5**-T3 + ST with Nano DAP @ 5 ml/kg seed + FS with Nano DAP @ 4 ml/liter of water at 30 DAG, **T6**- T2 + ST with Nano DAP @ 5 ml/kg seed + FS with Nano DAP @ 4 ml/litter of water at 30 DAG and **T7**- Control

Note: - ST - Seed treatment FS – Foliar spray DAG – Days after germination

Data recorded on wheat crop

Growth parameters: under the growth parameters data was recorded on Plant population 20 DAS and at harvest, Plant height (cm) at 30,60,90 DAS and at harvest, Fresh weight at 30,60,90 DAS and at harvest, Dry weight at 30,60,90 DAS and at harvest., No. of tillers at 30,60,90 DAS and at harvest andPost-harvest parameters were recorded**,** effective tillers (m^{-1}), No. of Grains Earhead-1, Test weight (g), Grains yield (kg ha^{-1}), Straw yield (kg ha^{-1}), Harvest index (%).

Statistical analysis: Data analysis was done from numerous observations were collated and then statistically analyzed using analysis of variance (ANOVA) procedures, with the treatment being evaluated using the F test. To examine the differences between treatment means, a critical difference (CD) was calculated for each character at a 5% level of significance. Before doing analysis of variance, the data on weed count and weed biomass were square root converted, i.e., x+0.5, and only transformed values were compared.

Economic Analysis:Cost of cultivation (Rs ha^{-1}): The cost of cultivation for each treatment is calculated using various inputs used to raise the crop under various treatments on a one-hectare basis. **Gross monetary returns (Rs ha^{-1})**: The value achieved from the crop received under each treatment was calculated as gross monetary returns (GMR) per hectare based on the current market price of the output (both grain and straw).**Netmonetaryreturns**: The net monetary returns (NMR) per hectare for each treatment were calculated by deducting the cost of cultivation from the GMR for that same treatment.

Netmonetary returns(Rs.)=Grossmonetary return–totalcostofcultivation

Benefit-costratio

The benefit-cost ratio, often known as profitability, is a statistic that shows monetary gains over each rupee invested under various treatments.

$$\text{Benefitcost ratio} = \frac{\text{Gross monetaryreturn (Rsha}^{-1}\text{)}}{\text{Totalcost ofcultivation(Rsha}^{-1}\text{)}}$$

Results and Discussion

Growth performance data were recorded among treatments as given below:

Plant Height and Plant Population: Plant height differed significantly (p = 0.05) among the various treatments. After 30 days of growth, Plant height ranged from 20.33 cm to 22.67 cm with an average value of 21.57 cm. The maximum plant height (22.67 cm) was recorded in the T1 which is 100% NPK (120:60:40 kg ha-1 Recommended dose)followed by T6 (22.33 cm) and minimum (20.33 cm) was noticed in T7 which is absolute control followed by T4 (22.00 cm) and T3 (20.67 cm). The variation in Plant height in different treatments can be attributed to its peculiarity to increase height of plant by cell enlargement and the influence of environment during the period of growthPlant population data were recorded non- significantly (p = 0.05) among the various treatments. Plant population data was recorded after 20 days. Highest plant population was recorded T1 treatment 38.93, which is closely followed by T6 98.92 and lowest was recorded T7 37.40.Plant height maximum recorded after 60DAS, 90DAS, at the time of harvest which was 57.00 cm, 84.00 cm, and 83.80 cm respectively which was followed by 55.67 cm, 81.67 cm and 81.17. Plant height minimum recorded after 60 days, 90 days, and at the time of harvest which was 44.33cm 64.33 cm and 63.83 cm. it shown on Fig. 1.Plants were able to avail the most of their available growth resources, resulting in increased plant height owing to the weed-free environment. Similar results were reported by Poudel*et.al.*, (2023).

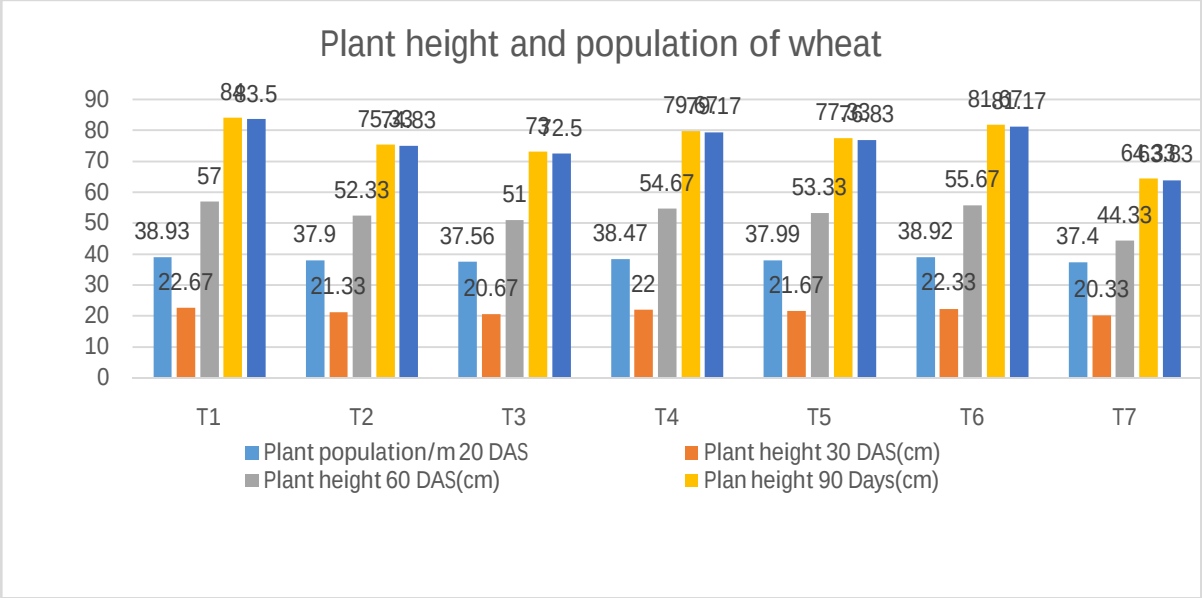

Fig. 1. Plant height and population m^{-1} of wheat

Statistical Analysis	Plant population m^{-1} 20 DAS	Plant height (cm) 30 DAS	Plant height (cm) 60 DAS	Plan height (cm) 90 Days	At harvest plant height (cm)
Mean	**38.16**	**21.57**	**52.61**	**76.47**	**75.97**
SE(m) (+)	**0.538**	**0.527**	**0.851**	**0.851**	**0.851**
SE(d)	**0.761**	**0.745**	**1.204**	**1.204**	**1.204**
CD (P=0.05)	**1.657**	**1.624**	**2.623**	**2.623**	**2.623**
CV %	**2.441**	**4.232**	**2.803**	**1.928**	**1.941**

Fresh weightm^{-1} and Dry Weightm^{-1}:in Fig. 2 ShowFresh weight differed significantly (p = 0.05) variation in among the various treatments. After 30 days, 60 days, 90 days of growth, fresh weight ranged after 30 days that is 117.75 gto 124.46 g with an average value of 120.96g. The maximum fresh weight is recorded after 30 days, 60 days and 90 days, T1 treatment recorded highest fresh weight is 124.46 g, 364.48 g and 409.28 g followed by T6 treatment which is 123.83 g, 362.66 g, 406.55 g respectively. Lowest fresh weight recorded after 30 days, 60 days and 90 days which is T7 117.75 g, 198.40 g and 199.07 g.Dry weight differed significantly (p = 0.05) variation in among the various treatments. After 30 days, 60 days, 90 days of growth, dry weight ranged after 30 days that is 29.44 g to 31.44 g with an average value of 30.24 g. The maximum dry weight is recorded after 30 days, 60 days and 90 days, T1 treatment recorded highest dry weight is 31.11 g, 127.57 g and 245.57 g followed by T6 treatment which is 30.96 g, 126.93 g, 243.93 g respectively. Lowest dry weight recorded after 30 days, 60 days and 90 days which is T7 29.44 g, 69.44 g and 119.44 g.The study is in line with the findings of Kumari *etal*. (2017).

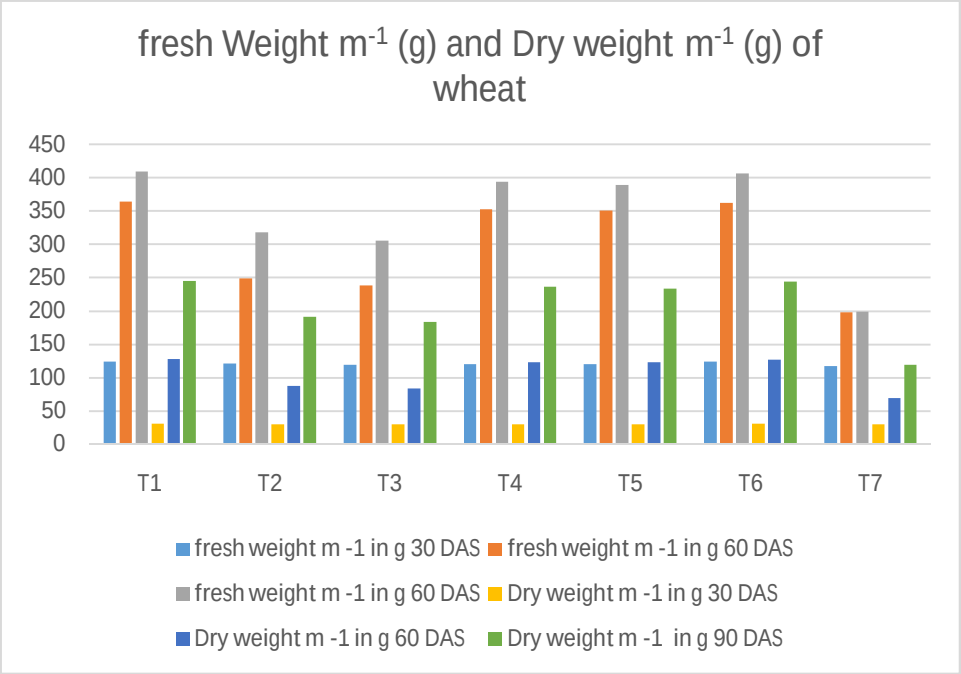

Fig. 2. Fresh Weight and Dry weight of wheat

Statistical Analysis	fresh weight m^{-1} in g 30 DAS	fresh weight m^{-1} in g 60 DAS	fresh weight m^{-1} in g 60 DAS	Dry weight m^{-1} in g 30 DAS	Dry weight m^{-1} in g 60 DAS	Dry weight m^{-1} in g 90 DAS
Mean	**120.96**	**302.35**	**346.14**	**30.24**	**105.82**	**207.68**
SE(m) (+)	**2.591**	**7.589**	**4.427**	**0.648**	**2.656**	**2.656**
SE(d)	**3.665**	**10.732**	**6.260**	**0.916**	**3.756**	**3.756**
CD (P=0.05)	**7.984**	**23.383**	**13.640**	**1.996**	**8.184**	**8.184**
CV %	**3.710**	**4.347**	**2.215**	**3.710**	**4.347**	**2.215**

Number of tillers m^{-1}: Number of tillers differed significantly (p = 0.05) variation in among the various treatments. After 30 days, 60 days, 90 days of growth, number of tillers ranged after 30 days are 48.00 to 50.11 with an average value of 48.51 tillers. The maximum tillers are recorded after 30 days, 60 days and 90 days, Fig. 3 show, T1 treatment recorded highest number of tillers 50.11, 75.11 and 75.11 followed by T6 treatment which is 49.03, 73.13 and73.13 tillers respectively. The smaller number of tillers was recorded after 30 days, 60 days and 90 daysfrom T7 i.e. 48.00, 63.00 and 63.00 tillers respectively. Crop growth, leading in the efficient use of growth resources, resulting in these treatments having the higher number of tillers. These results were confirmed byRajput *et.al.* (2022) and Malothe*t.al*. (2024)

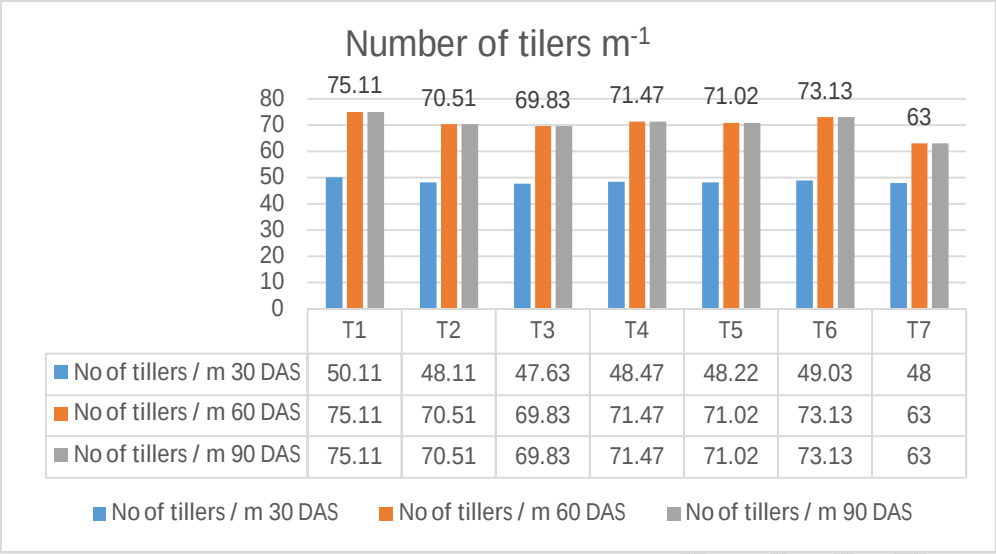

Fig.3. Number of tillers m^{-1}

Statistical Analysis	No of tillersm^{-1}30 DAS	No of tillers m^{-1} 60 DAS	No of tillers m^{-1} 90 DAS
Mean	**48.510**	**70.581**	**70.5814**
SE(m) (+)	**0.709**	**0.709**	**0.709**
SE(d)	**1.003**	**1.003**	**1.003**
CD (P=0.05)	**2.185**	**2.185**	**2.185**
CV %	**2.531**	**1.740**	**1.740**

Grainsearhead^{-1}: In the fig.4, Grains earhead^{-1} recordeddiffered significantly (p = 0.05) variation in among the various treatments, Grains earhead^{-1}highest recorded T1 38.20 followed by T6 35.20 and lowest 31.6 was recorded from T7 which is followed by T3 32.60. Grains earhead^{-1}ranged between 31.60 to 38.20 and average of among treatments is recorded 34.31.Spikelet per ear head recordeddiffered significantly (p = 0.05) variation in among the various treatments, Spikelet earhead^{-1} highest recorded T1 12.73 followed by T6 11.73 and lowest was recorded 10.53 which is followed by 10.87 Spikelet earhead^{-1}ranged between 10.53 to 12.73 and average of among treatments is recorded 11.43.

Earhead^{-1}Length (cm): Earhead^{-1}length was recorded significantly (p = 0.05) variation in among the various treatments,earhead^{-1}length highest recorded T1 8.95 cmclosely followed by T6 8.90 cm and lowest was recorded T7 7.45 cm. Earhead^{-1}length ranged between 7.45cm to 8.95cm and

average of among treatments is recorded 8.45cm.This study is in line with the findings ofMahachandramuki*etal*. (2023)

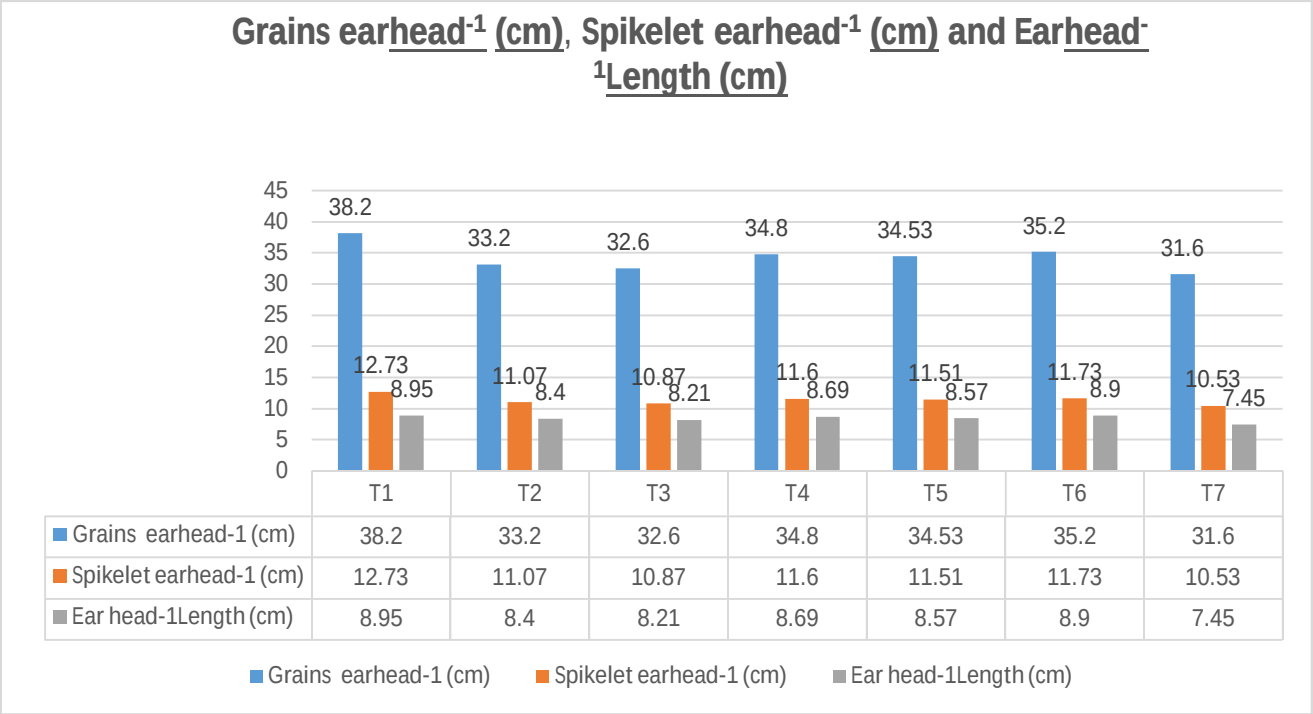

Fig.4. **Grains in per ear head^{-}, Spikelet earhead^{-1}**and **Ear head^{-1}Length (cm)**

Statistical Analysis	Grains earhead^{-1} (cm)	Spikelet earhead^{-1}(cm)	Earhead^{-1}Length (cm)
Mean	34.30	11.43	8.45
SE(m) (+)	**0.957**	**0.319**	**0.125**
SE(d)	**1.354**	**0.451**	**0.177**
CD (P=0.05)	**2.950**	**0.983**	**0.385**
CV %	**4.834**	**4.834**	**2.562**

Test weight: Test weight and net plot yield was recorded significantly (p = 0.05) variation in among the various treatments, Test weight was highest recorded T1 93.60 g closely followed by T6 39.42 g and lowest was recorded T7 35.42 g. Test weight ranged between 35.42 g to 39.60 g and average of among treatments is recorded 37.85 g. Net plot yield was highest recorded T1 6.93 kg closely followed by T6 6.83 kg and lowest was recorded T7 3.25 kg. Net plot yield ranged between 3.25 kg to 6.93 kg and average of among treatments was recorded 5.77 kg. it was show on Fig. 5. Similar findings were also reported by Kumar *etal*. (2021).

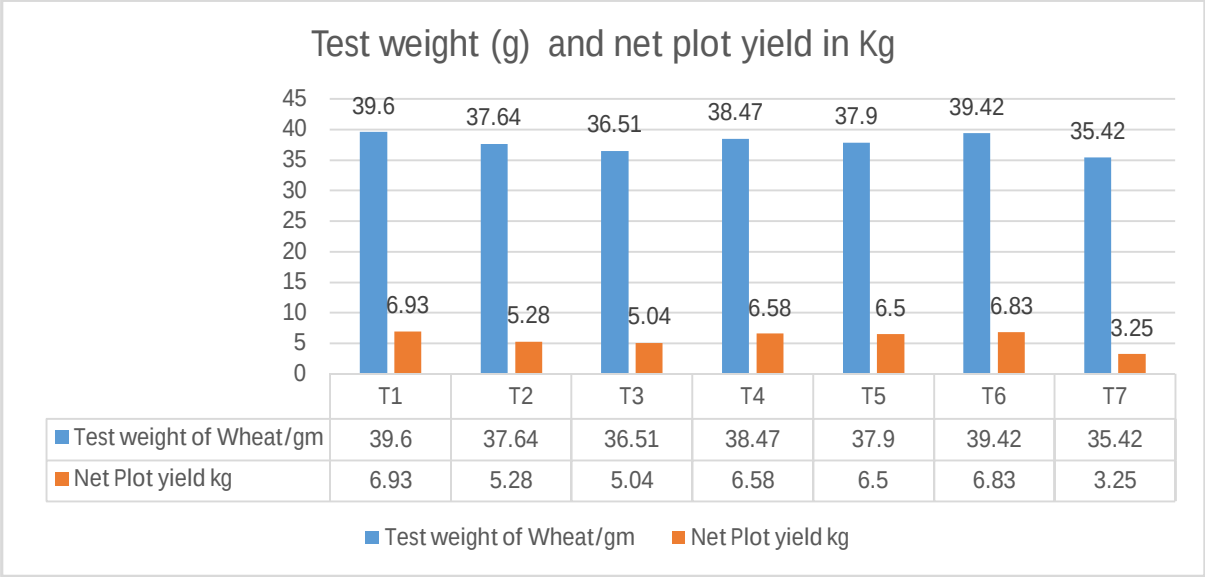

Fig.5. Test weight g and net plot yield in kg

Statistical Analysis	Net plot yield (kg)	Test weight of wheat (g)
Mean	**5.77**	**37.85**
SE(m) (+)	**0.072**	**0.500**
SE(d)	**0.102**	**0.707**
CD (P=0.05)	**0.223**	**1.541**
CV %	**2.169**	**2.289**

Yield and straw yield:

In the Fig. 6., Yield and straw yield was recorded significantly (p = 0.05) variation in among the various treatments, the highest wheat yield was recorded in T1 of 4226.33kg ha^{-1}which was closely followed by T6 4164.67 kg $ha^{-1}$and lowest yield was recorded in control T7 1984.33 kg ha^{-1}. Yield of wheat ranged between 1984.33kg $ha^{-1}$to 4226.33 kg $ha^{-1}$and average of among treatments was recorded 3520.94 kg ha^{-1}. The highest Straw yieldwas recorded at T1 6339.5 kg ha^{-1}closely followed by T6 6330.25kg $ha^{-1}$and the lowest straw yield 3174 kg $ha^{-1}$was recorded from T7.Similar findings were also reported by Singh*e.al.* (2023).

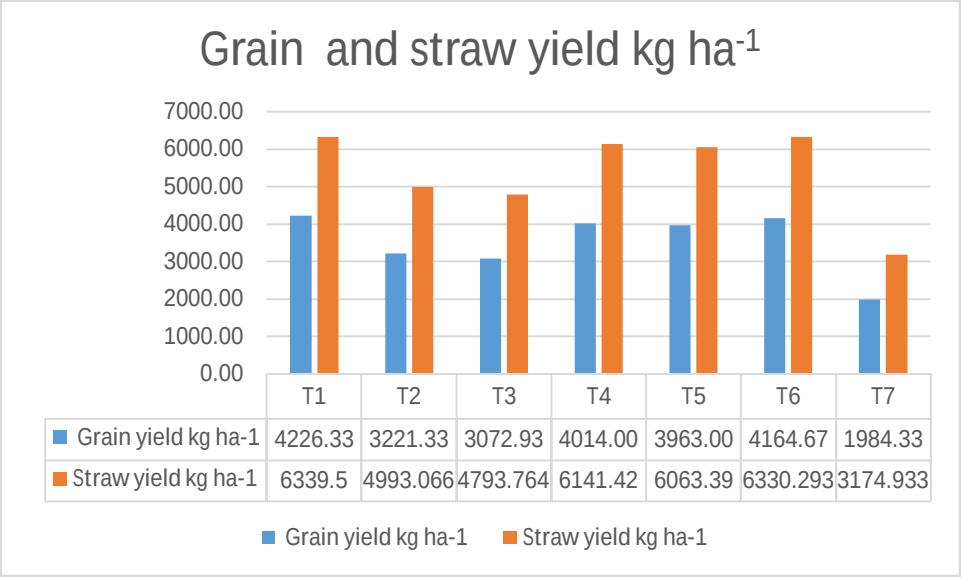

Fig.6. Yield kg ha^{-1} and straw yield kg ha^{-1}

Statistical Analysis	Straw Yield (kg ha^{-1})	Grain yield (kg kg ha^{-1})
Mean	5405.20	3520.94
SE(m) (+)	67.470	44.084
SE(d)	95.417	62.344
CD (P=0.05)	207.896	135.837
CV %	2.162	2.169

Harvest index (%): Harvest index was recorded significantly (p = 0.05) variation in among the various treatments, Fig. 7. Show Harvest index of wheat was highest recorded in T1 40.03 % which was closely followed by T6 39.69 % and lowest was recorded in control T7 37.89 %. average of Harvest index was recorded 39.28 %.Higher value of harvest index T1 (40.03 %) because of higher amount of photosynthate assimilation as compared to other the treatments. Similar findings were also reported by Kumar *e.al.(*2011) and Jaidev *et al.* (2012).

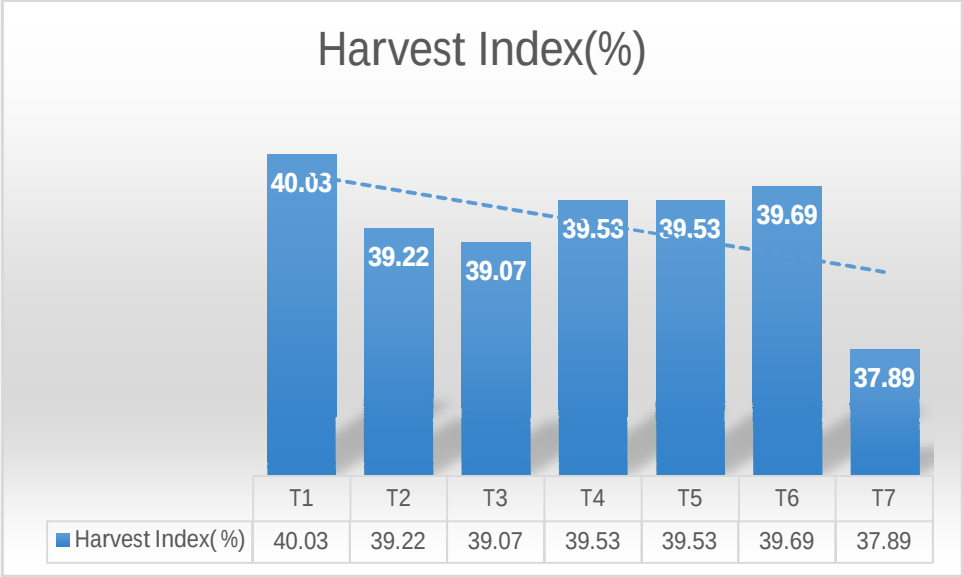

Fig.7. Harvest Index (%)

Statistical Analysis	Harvest Index (%)
Mean	39.28
SE(m) (+)	0.302
SE(d)	0.659
CD (P=0.05)	0.943
CV %	0.214

Partial Budget Analysis: The partial budget of the experiment is show that in table 1. The maximum Cost of cultivation (Rs.ha-1) was recorded in T1 treatment followed by T6, T2 and T4 and the minimum cost of cultivation was recorded under the treatment T7. In point of view Gross Monitoring returns (GMR) and Net Monitoring returns (NMR), The highest GMR and NMR were recorded in T1 and minimum was recorded T7. In case of B-C ratio, the maximum was observed in the T5 treatment it is followed by T1, T6 and T4. However, the minimum B-C ratio was found under T7.

Effects of Nano DAP on Economics of various treatments				
Treatment	**Cost of cultivation(Rs.ha-^{1})**	**Gross Monitoring returns (Rs.ha-^{1})**	**Net Monitoring returns (Rs.ha-^{1})**	**B-C Ratio**
T1	46,430	116,630	70,200	2.51
T2	43,659	87,346	43,687	2.00
T3	42,358	83,509	41,151	1.97
T4	45,519	110,766	65,248	2.43
T5	43,578	109,918	66,340	2.52

T6	45,879	111,752	65,874	2.44
T7	38,453	56,185	17,732	1.46

Conclusion

Based on experimental results, with respect to growth parameters, yield attributing characters and yield, it can be concluded that wheat varietyHI-1634 (Pusha Ahilya) the result of the experiment show that the RDF treatment (T1) is better as compared to rest of the treatments such like Growth parameters, yield attributes and yield but, in prospect of economically the treatment T5 (T3 + ST with Nano DAP @ 5 ml/kg seed + FS with Nano DAP @ 4 ml/liter of water at 30 DAG) is best for farmers because in this treatment can save 50% N and P cost in rupees.

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