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Performance of wheat varieties (*Triticum aestivum* L.) under different fertility levels on growth and yield

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Abstract

A field experiment on "Performance of wheat varieties (*Triticum aestivum* L.) Under different fertility levels" was conducted at Career Point University during Rabi 2023-24 to investigate the effect of different levels of farmyard manure on yield and quality of wheat varieties. The soil of experimental field was loamy sand having normal pH and medium organic carbon. The available nitrogen and potassium were in medium range and available phosphorus status was high. The experiment was laid out in split plot design with five nutrition treatments fertilizer to supply 60, 90 and 120 kg N ha^{-1}, recommended chemical fertilizers and unfertilized control) in main plots and three varieties (Raj 3077, Lok 1 and DBW302) in sub plots. A significant improvement in growth and yield attributing characters was recorded with the application of recommended chemical fertilizers over rest of the treatments. The highest level of fertilizer (M3), supposed to supply 1.5 times higher nitrogen over the recommended nitrogen, resulted in significantly lower grain yield (43.1 q ha^{-1}) than the recommended chemical fertilizers (55.6 q ha^{-1}) and the decrease was 22.5 per cent. However the highest level of fertilizer was significantly better than the other two levels of fertilizer and unfertilized control. The grain yield of varieties did not differ significantly among themselves with the varying levels of nutrition. Protein content and sedimentation value were significantly higher in Raj 3077.

Keywords: Chemical fertilizers, Grain yield, Quality, Variety, Wheat

I Introduction

Wheat is a rabi season crop and is the main cereal crop of India. It is mainly grown in the north and northwestern states of India like Uttar Pradesh, Madhya Pradesh, Punjab, and Haryana. The wheat in India is majorly soft to medium hard, has medium protein, and is white bread wheat. The cultivation of wheat crop requires a moist and cool climate and can be grown in any soil type. India is divided into 6 major wheat growing zones, namely, Northern Hill Zone, Northwestern Plains Zone, Northeastern Plains Zone, Central Zone, Peninsular Zone, and Southern Hill Zone. In this blog, we will discuss the current scenario of wheat production and the benefits of wheat production and discuss the largest wheat producing states in India. Before that, let's discuss the importance of wheat in India and the factors responsible for wheat production in India. Rajasthan has made significant strides in wheat production in recent years. Its wheat production stands at 9484 thousand hectares and covers an area of 3118 thousand tonnes. Despite its arid and semi-arid climate, the state has successfully adopted water-efficient techniques, improved farming practices, and introduced drought-tolerant wheat varieties. Key wheat-growing districts in Rajasthan include Sikar, Jaipur, Jodhpur, and Nagaur. In the study region, the productivity of wheat is much lower as compared to average state productivity. The basic and prime reasons for lower productivity in the region identified are viz; cultivation of the crop under rainfed conditions, poor knowledge of drought tolerant improved varieties, and poor adoption of production practices. Further, low productivity in the region has also been ascribed to improper management of irrigation water to the crop, especially at critical stages of growth for the proper growth and development (Joshi *et al.*, 2007). Moreover, in the recent past it has also been noticed that owing to late harvesting of preceding kharif crops, more than 50% sowing of wheat gets delayed till December or early January. The delayed sowing leads to substantial loss in grain yield, due to unavailability of sufficient irrigation water at the later stages. Furthermore, poor agronomic practices such as seed rate, selection of suitable varieties, nutrient management, weed management and irrigation management etc. are also responsible for low productivity of wheat in India (Tiwari*et al.*, 2014). It is evident from the findings, that there is no scope for area expansion, hence additional production has to added to the national food basket by increasing the per hectare productivity (Nagarajan, 1997). Keeping these in view, FLDs of improved production technology on wheat were conducted to enhance the productivity, economic returns and convincing the farmers for adoption of improved production technologies.

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Improvement in wheat production can be achieved by enhancing through the development of new cultivars having wider genetic base and manage from integrated use of resources, as the land area under wheat is not expected to expand further. Balanced fertilizer through organic and inorganic sources improves the soil health as well as boosts the productivity of wheat. Organic matter is the substrate for a large number of soil living beneficial organisms which are essential to keep the plant healthy. Enriched fertilizer improves the nutrient availability and increases wheat yield. Organic matter in soil increases the water holding capacity, cation exchange capacity as well as improves the soil structure for better performance of microorganisms. The soil which enriched in organic matter has been found to respond better to the application of nitrogenous fertilizers (Subbiah and Bajaj, 1968). About 40% of cattle dung is available for manuring, rest being wasted or used as fuel (White, 1957). Thus, a good amount of organic waste is lost which is an important input for agricultural production. In the event of widespread energy crisis and deterioration of soil fertility due to intensive agriculture and imbalance use of fertilizers, it is highly desirable for making massive efforts to adopt organic matter recycling as a source of bioenergy and to supplement the demand gap of N, P, K as well as to enrich the soil in respect to micronutrients. Thus, the combination of fertilizer with inorganic fertilizers may be highly effective for increasing the yield under late sown wheat as well as better quality of produce in addition to sustaining biological health and maintaining balanced C: N ratio of the soil. Thus present study was undertaken to assess the performance of wheat varieties under various fertility levels. Fertilizer is the single most important input in modern agriculture to raise the crop productivity. The combined use of NPK fertilizers plays an important role in wheat production. Application of NPK in balanced share at proper time has great impact on wheat yield. Plant species, even varieties within species vary in their behaviors to obtain and utilize NPK for grain production. Nutrients play an important role in boosting the crop production. Crop species of wheat requires higher amount of nitrogen, phosphorus and potassium fertilizers. For maximizing production per unit area, growing of high yielding varieties with higher doses of fertility level is necessary. The chemical fertilizers are under wide recommendation to fulfill the nutrient need of this crop (Kumari*et al.*, 2013).

II Literature Review:

Material and Method : The present investigation entitled "**Performance of wheat varieties (*Triticumaestivum* L.) under different fertility levels**." was carried out during rabi season of 2023-24.The experiment was conducted at the Agriculture Research Farm, Career Point University, Kota situated in South-East part of Rajasthan at an altitude of 579.5 metre above mean sea level and at 24º35 N latitude and 73º42 E longitude. The region falls under agro-climatic zone V (humid South eastern Plain) of Rajasthan. The experiment was laid out in split plot design with nutrition sources in main plots and wheat varieties in sub plots.**Treatments**, **Varieties (3) :**V_1 : Raj 3077, V_2 : Lok 1and V_3 : DBW 303 **doses of Fertilizers application :**M_1 : Control, M_2 : 60kg N + 20 Kg P_2O_5 + 20 kg K_2O Kg/ha, M_3 : 90kg N + 30 Kg P_2O_5 + 30 kg K_2O Kg/ha and M_4 : 120kg N + 40 Kg P_2O_5 + 40 kg K_2O Kg/ha. Observations recorded was five plants per plot were selected randomly to measure the height from ground level to the base of top most fully opened leaf up to 60 DAS, up to the base of flag leaf at 90 DAS and up to base of the ear at 120 DAS and at harvest. The germination plants in one square meter area were from three randomly selected locations with quadrate in each plot after 15 DAS of crops. The average was taken and finally plant population was expressed.Above ground plant samples from 50 cm row length were taken periodically at 30, 60, 90, 120 DAS and at harvest. The samples were first sun dried. Thereafter, these were kept in an oven at a temperature of 65±10C to achieve constant weight. The dry weight thus obtained was recorded and expressed as quintal ha-1.The numbers of tillers were recorded from five places in each plot at 30, 60, 90 days after sowing and at harvest stage of crop growth by using quadrate. Then average value was worked out in per meter square. Effective tillers per metre row length from two spots in each plot were counted at harvest and were converted to per metre square area. Five ears were selected at random from each plot and their length excluding awns was measured and then average values were calculated. The average length was expressed in cm. Randomly selected five ears were taken from each plot and threshed manually. The number of grains were counted and averaged for number of grains ear-1.Length of ten selected spikes from each plot and length measured carefully by scale from the neck node to the tip of last grain and average value was worked out to find out the length of single spike.One thousand grains from produce of each plot were taken and their weight was recorded. The thousand grain weight was expressed in grams. The total produce was weighed in bundles after harvesting and threshed thereafter. The weight of grains was recorded. The straw weight was obtained after deducting the weight of grains from total bundle weight. Grain and straw yield were computed and expressed as quintals per hectare.

III Methodology

Plant height : Plant height is an important index of the plant development. It gives an idea to predict the growth rate and yield of the crop. The perusal of data on periodic plant height indicates a progressive increase in plant height with the advancement in age of crop. The periodic plant heights at 30, 60, 90, 120 days after sowing (DAS) and at harvest are presented in Table 1.The plant height at 30 DAS was not significantly affected by the nutrition treatments but the application of fertilizer and chemical fertilizers increased plant height significantly at 60, 90, 120 DAS and at harvest than the control (unfertilized). The non-significant differences at 30 DAS might be due to less demand of nutrients at initial stage that might have been available in all the treatments. However, Kaur (2010) reported that at 30 DAS the plant height had non-significant differences as at initial growth stage plants were unable to utilize the applied nutrients.The maximum plant height (34.6 cm) at 60 DAS was obtained with the higher level of fertilizer (M4) which was statistically at par with recommended chemical fertilizers (32.9 cm). M4 gave significantly higher plant height than the other levels of fertilizer (M3 and M2) and unfertilized control. The plant height (31.1cm) recorded with the M3 (equivalent to recommended nitrogen) was statistically at par with the chemical fertilizers (RDF) and lower level of fertilizer (M2). All the treatments resulted in significantlyhigher plant height than the unfertilized control (24.8 cm). At 90 DAS the maximum plant height was recorded with the application of chemical fertilizers (67.8 cm) but it was statistically at par with M4 (65.3 cm).The similar results at 90 DAS were observed by **Channabasana gowda *et al*** (2008) who compared 12.5t fertilizer ha^{-1} with RDF. The plant height with chemical fertilizers (RDF) at 120 DAS and at harvest (97.4 cm and 104.9 cm, respectively) was significantly higher than all the fertilizer levels and unfertilized control. The similar results were reported by **Kharub and Chander (2010)** and **Tanveer *et al* (2010).** The higher mineralization rate of nutrients from decomposing fertilizer might have supplied high amount of nutrients to the plant initially but it might have not sustained after 90 DAS due to slow release of nutrients from fertilizer. Whereas, inorganic fertilizer might have supplied readily available nitrogen throughout the growing period. Though M3 at 120 DAS and at harvest resulted in significantly lower plant height (86.6 cm and 94.3 cm, respectively) than M4 , but it was statistically at par with M2 (85.7 cm and 93.3 cm, respectively). The higher availability of nutrients with higher fertilizer level might have resulted in higher plant height. The results conform to the findings of **Jan and Noor (2007), Kharub and Chander (2008)** and **Jan *et al* (2011).** Unfertilized control resulted in significantly lower plant height than all the other treatments. This might be due to lesser availability of nutrients in the absence of any external input. The results corroborated the findings of **Sushila and Giri (2000) and Shiva kumar and Ahlawat (2008).**The data revealed that the plant height varied with the varieties. The variety LOK-1 attained significantly higher plant height (15.0 cm) than the other varieties at 30 DAS due toits higher initial growth rate. But at 60 and 90 DAS the plant height of LOK-1 was statistically at par with the variety RAJ 3077. DBW 303 showed significantly lower plant height at 30, 60 and 90 DAS than the other varieties but at 120 DAS and at harvest it resulted in significantly higher plant height than RAJ 3077 and LOK-1 (99.3 cm and 107.1 cm, respectively). LOK-1 recorded significantly lower plant height than the other varieties at 120 DAS and at harvest. Though the plant height is the resultant of the interactions between genetic character and environment, the duration of the crop also affects it significantly. The growing duration of variety LOK-1 was significantly shorter and DBW 303 was significantly longer than the other varieties. So at 120 DAS and at harvest DBW 303 resulted in significantly higher plant height than the other varieties. The plant heights of DBW 303, RAJ 3077 and LOK-1 have been reported as 110 cm, 86 cm and 80 cm (Anonymous 2011b) which support the findings.

Dry matter accumulation is the result of total accumulation of photosynthetic formed and total nutrient uptake by the plant up to the stipulated growth period. The dry matter recorded at 30, 60, 90, 120 DAS and at harvest differed significantly with nutrition and variety (Table 2).The dry matter accumulation by the varieties varied with the growing period and growth habit. At 30, 60 and 90 DAS, the dry matter accumulation was significantly higher by the variety LOK-1 (4.3, 17.4 and 60.5 q ha^{-1}, respectively) than the other varieties. It might be due to its fast initial growth. The trend for dry matter accumulation was reverse for DBW 303. It resulted in significantly lower dry matter accumulation (3.0 and 11.8 q ha^{-1} at 30 and60 DAS, respectively) than the other two varieties, but at 90 DAS the dry matter accumulation (46.1 q ha^{-1}) was statistically at par with RAJ 3077. At 120 DAS and at harvest, the dry matter accumulation was significantly higher for DBW 303 because of its more plant height and significantly longer duration of maturity than the other varieties. At 120 DAS, LOK-1 gave significantly higher dry matter accumulation (77.4 q ha^{-1}) than RAJ 3077 (71.9 q ha^{-1}), but at harvest they were statistically at par. Due to significantly shorter duration of

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LOK-1 than the other two varieties, it resulted in less increase in dry matter accumulation from 120 DAS to harvest stage as compared to the other varieties.

The tillers m^{-2} is a genetic character of a variety, but it may vary with the influence of growing environment. At 60 DAS, the variety DBW 303 resulted in significantly higher tillers m-2 (545.3) and variety RAJ 3077 produced significantly lower than the other varieties. At 90 and 120 DAS, the variety DBW 303 gave significantly higher tillers m^{-2} (452.2 and 381.6, respectively), whereas RAJ 3077 resulted in lowest tillers m-2 (382.9 and 321.6, respectively) which were statistically at par with the LOK-1 (401.0 and 324.2, respectively).

The highest number of effective tillers m^{-2} (422.4) was recorded with the application of chemical fertilizers (RDF) and it was significantly higher than all the other treatments. This might be due to the proper supply of readily available nutrients in required amount with the chemical fertilizers. Though the results are supported by **Channabasana gowda *et al* (2008)** and **Dhar *et al* (2010)**, these were contradictory to the findings of **Singh *et al* (2008b)** who reported that 15 t fertilizer ha^{-1} was able to produce effective tillers m^{-2} statistically at par with the RDF in a two year study in cropping system mode in arid region of Rajasthan. The fertilizer level supplying nitrogen equivalent to the chemical fertilizers (M3), resulted in significantly lower effective tillers m^{-2} (272.0) than the higher level of fertilizer (311.1), but it was statistically at par with the lower level of fertilizer (249.7). The higher level of fertilizer gave significantly higher effective tillers m^{-2} than the lower fertilizer levels and unfertilized control. The results are supported by the findings of **Jan and Noor (2007).** Unfertilized control gave significantly lower effective tillers m^{-2} thanother treatments. **Nehra *et al* (2001)** and **Shivakumar and Ahlawat (2008)** also reported significant increase in effective tillers m^{-2} with fertilizer than unmanured control.

IV Result and Discussion

The perusal of data revealed that ear length was significantly more (9.94 cm) with the recommended dose of chemical fertilizers (RDF) than all the other treatments. The similar results were reported by **Singh *et al* (2007)** who compared the ear length of wheat with 100 kg N ha^{-1}, 150 kg N ha^{-1} through inorganic nutrition, fertilizer (5 tha^{-1}) and unfertilized control. Higher level of fertilizer (M4) gave significantly more ear length (9.46 cm) than the lower level of fertilizer (M2) and unfertilized control, but it was statistically at par with the medium level of fertilizer (M3). Medium level of fertilizer (M3) resulted in the ear length that was statistically at par with the lower level of fertilizer (M2) and unfertilized control. The results corroborated the findings by **Tanveer *et al* (2010)** where fertilizer application gave statistically at par ear length with unfertilized control.

Variety RAJ 3077 gave maximum number of grains ear^{-1} (45.4) which was statistically at par with LOK-1. The variety DBW 303 gave significantly lower number of grains ear^{-1} (31.3) than the other varieties. All the interactions were found to be non-significant.

Variety DBW 303 resulted in significantly higher 1000-grain weight (49.0 g) than the other two varieties. RAJ 3077 gave significantly lower 1000-grain weight (43.4 g) than LOK-1 and DBW 303. The results support the earlier findings in which DBW 303 has been reported as a bold seeded variety (**Anonymous 2011b**).

The increase in grain yield was due to the cumulative effect of subsequent increase in all the yield attributing characters. The recommended chemical fertilizers and increasing fertilizer levels increased the number of effective tillers m^{-2}, ear length and number of grains ear^{-1} (Table 4.3). The higher availability of nitrogen to the plants increased the grain yield significantly. The recommended chemical fertilizers supplied readily available nitrogen to the crops throughout the growing period whereas nutrient release from fertilizer is a slow process. So the availability of nitrogen might be less with the fertilizer application. The fertilizer level supplying nitrogen equivalent to 187.5 kg N ha^{-1} was unable to meet the required amount of 125 kg N ha^{-1} to wheat and resulted in lower grain yields than that with RDF.

The varietal differences in straw yield were mainly due to their genetic characteristics. The straw yield with the variety DBW 303 was significantly higher (65.0 q ha^{-1}) than the other two varieties. The straw yield of the variety LOK-1 was statistically at par with RAJ 3077.

The medium level of fertilizer (M3) gave statistically at par HI (42.6%) with the lower level of fertilizer (42.3%) and unfertilized control (42.6%). Higher level of fertilizer (M4) gave significantly lower (40.3%) HI than all the other treatments. The similar results were reported by **Singh and Kaur (2004)** who reported the significant decrease in HI with 15 t fertilizer ha^{-1} than unmannered control.

The variety DBW 303 gave significantly lower HI (37.3%) than the other varieties due to its higher straw yield. The varieties RAJ 3077 and LOK-1 gave statistically at par HI value (44.8% and 45.2%, respectively).

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Table 1: Periodic plant height and plant population of wheat as affected by nutrition and varieties.

Treatment		Plant height (cm)				Plant Population
	30DAS	60DAS	90DAS	120DAS	Atharvest	15 DAS
Nutrition						
M4	14.8	34.6	65.3	90.2	97.9	161.00
M3	14.3	31.1	61.1	86.6	94.3	163.00
M2	13.3	29.0	60.1	85.7	93.3	166.00
M1	12.8	24.8	54.1	79.2	86.6	159.00
CD(p= 0.05)	**NS**	**3.4**	**3.5**	**3.5**	**3.3**	**NS**
Varieties						
V3	14.3	31.7	63.5	83.0	91.1	167.00
V2	15.0	31.8	62.0	81.1	88.0	160.00
V1	12.1	28.1	59.6	99.3	107.1	158.00
CD(p= 0.05)	**0.7**	**1.6**	**1.6**	**1.7**	**1.8**	**2.31**
Interactions	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Table 2: Periodic dry matter accumulation of wheat as affected by nutrition and varieties.

	Dry matter accumulation (q ha^{-1})				
	30 DAS	60 DAS	90 DAS	120 DAS	At harvest
Nutrition					
M4	4.1	15.7	59.1	95.8	102.8
M3	3.8	14.5	45.0	70.4	81.2
M2	3.4	13.1	42.7	66.5	76.0
M1	2.9	11.5	40.7	53.7	62.3
CD(p= 0.05)	**0.7**	**1.4**	**7.1**	**9.7**	**5.2**
Varieties					
V3	3.4	14.1	49.6	71.9	82.9
V2	4.3	17.4	60.5	77.4	83.8
V1	3.0	11.8	46.1	87.3	98.2
CD(p= 0.05)	**0.4**	**1.1**	**4.6**	**5.1**	**7.2**

Interactions	**NS**	**NS**	**NS**	**NS**	**NS**

Table 3: Yield attributes of wheat as affected by nutrition and varieties.

Treatment	Effective tillers m^{-2}	Ear length (cm)	Number of grains ear^{-1}	1000-grain weight (g)
Nutrition				
M4	311.1	9.46	40.9	46.9
M3	272.0	9.28	40.1	46.4
M2	249.7	9.10	39.9	46.3
M1	204.3	8.95	38.8	45.2
CD(p= 0.05)	**38.5**	**0.35**	**2.0**	**1.5**
Varieties				
V3	273.4	9.60	45.4	43.4
V2	275.3	9.35	44.6	44.8
V1	327.0	9.08	31.3	49.0
CD(p= 0.05)	**23.2**	**0.31**	**2.2**	**1.0**
Interactions	**NS**	**NS**	**NS**	**NS**

Table 4: Effect of nutrition and varieties on grain and straw yield, harvest index and days to maturity of wheat

Treatment	Grain yield qha^{-1})	Straw yield (qha^{-1})	Harvest index (%)	Days to maturity
Nutrition				
M4	43.1	64.7	40.3	139.3
M3	36.8	50.1	42.6	136.3
M2	33.5	46.6	42.3	134.0
M1	27.3	38.1	42.6	132.3
CD(p= 0.05)	**3.1**	**3.8**	**1.7**	**2.9**
Varieties				
V3	39.6	48.2	44.8	136.6
V2	39.9	48.6	45.2	130.6

V1	38.3	65.0	37.3	143.0
CD (p= 0.05)	**NS**	**4.9**	**1.5**	**1.8**
Interactions	**NS**	**NS**	**NS**	**NS**

V Conclusion:

The quantity of fertilizer supplying nitrogen equivalent to the recommended nitrogen to wheat gave significantly lower grain yield (33.5 q ha^{-1}) than that with recommended fertilizers (55.6 q ha^{-1}). Even the quantity of fertilizer supplying nitrogen equivalent to 1.5 times the recommended nitrogen failed to produce the grain yield as that with recommended fertilizers. However, the quantity of fertilizer supplying 187.5 kg N ha^{-1}gave significantly higher grain yield than the lower fertilizer levels supplying 125 and 62.5 kg N ha^{-1}. The performance of varieties (RAJ 3077, LOK-1 and DBW 303) did not differ with the variation in fertilizer levels. Protein and gluten content were significantly lower under all the levels of fertilizer as compared to chemical fertilizers, but grain hardness and sedimentation value under highest level of fertilizer were statistically at par with chemical fertilizers. Mineral content except copper was significantly higher under higher dose of fertilizer than chemical fertilizers. Quality characteristics of all the varieties were in optimum range but variety RAJ 3077 had significantly higher grain protein was significantly higher in DBW 303.

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