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EFFECT OF AGRONOMIC MANIPULATIONS AND THEIR INTERACTIONS ON YIELD, SOIL FERTILITY AND NUTRIENT UPTAKE IN DIFFERENT VARIETIES OF WHEAT UNDER IRRIGATED CONDITIONS OF J&K UNION TERETORY, INDIA

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ABSTRACT

Experiments were conducted at Research Farm of Agromet Research Centre, SKUAST-Jammu, during *rabi* 2015-16 and 2016-17, and comprised of three varieties, three sowing environments and three N-levels laid out in split-split plot design. WH 1105 variety recorded significantly superior grain and biological yield as compared to HD 2967 and RSP 561. Early sowing (25th October) of wheat produced statistically higher grain, straw and biological yield values than normal (14th November) and late sowing (4th December) environments along with higher yield attributes. The higher nitrogen dose 25 kg (125 kg/ha), than recommended dose (100 kg/ha) exhibited higher yield attributing parameters and yield of wheat crop. Significantly higher nutrient (NPK) uptake recorded with wheat variety WH 1105 followed by HD 2967 and RSP 561. However, wheat crop sown on 25th October (early sowing) registered statistically higher NPK uptake followed by normal and late sowings. Numerically higher NPK uptake was observed when wheat was supplied with 150 kg N/ha followed by statistically at par values of uptake recorded in 125 kg N/ha and the lowest recorded in 100 kg N/ha.

***Keywords*:** Wheat, varieties, sowing environments, uptake, soil fertility, grain and biological yields

Introduction

India is one of the main wheat producing countries of the world after China. It is the second staple food crop of India, cultivated on about 30.60 million hectare with the production of 98.38 MTs and productivity of 32.16 q/ha (Anonymous, 2017). In J&K UT, it is grown on about 0.32 mha with production and productivity of 0.50 MTs and 1550 kg/ha, respectively (Anonymous, 2016). Several agronomic and climatic factors prevent the full intrinsic yield potential of wheat varieties from being realized in a particular region. Various adverse climatic effects like terminal heat stress and excessive rainfall during reproductive stage reduce the yield to a great extent. The fluctuations in climatic conditions enhanced the vulnerability of the crop to vagaries of various weather factors. Delay in sowing by each day causes a remarkable yield loss in wheat according to various field experiments (Ortiz-Monasterio *et al.*, 1994) which was largely due to terminal heat stress. Adequate growth and augmentation of crop could be obtained by adjusting the sowing environments which leads to better yield; as perfect sowing environment exploits the full genetic potential of a particular variety by providing optimum growth conditions such as temperature, light, humidity and rainfall (Gupta *et al.,* 2020). The unfavourable environments created by high temperature mostly during reproductive stages especially grain filling stage could be minimized by adjusting the sowing time to an optimum time for different varieties, which are suitable for early, normal and late sown environmental conditions for assured higher yield (Gupta *et al*., 2020a; Gupta *et al*., 2022). The accumulated temperature is considered as the principal factor affecting year-to-year variation in phenology (Gupta *et al.,* 2021). The optimum sowing time and selection of improved cultivars play a remarkable role in exploiting the yield potential of the crop under particular agro-climatic conditions (Gupta *et al.*, 2020).

A perfect sowing environment exploits the full genetic potential of a particular variety by providing optimum growth conditions such as temperature, light, humidity and rainfall. Advance or delay in sowing date, increasing N application and choice of suitable variety with the best thermal requirement represent the main agronomic manipulations which help to maintain existing crop production levels (Ventralla *et al.*, 2012; Gupta *et al*., 2020). The unfavourable environments created by high temperature mostly during reproductive stages especially grain filling stage could be minimized by adjusting the sowing time to an optimum time for different varieties, which are suitable for early, normal and late sown environmental conditions for assured higher

yield (Gupta *et al*., 2020a). It is also reported by the various researchers that the cool period for wheat crop in India is shrinking, while the threat of terminal heat stress is expanding (Gupta *et al*., 2022a; Gupta *et al*., 2023).

Nitrogen is a key element for plant nutrition and other management practices which ultimately increases the yield of wheat crop (Cui *et al.,* 2010). High yielding new varieties can never be fully exploited with the existing fertilizer practice and thus fails to provide adequate yield. Since the information about the response of wheat varieties to sowing environments and N-levels under low altitude irrigated sub tropical region of Jammu under lower Shivalik zone of Himalayas is lacking. To overcome these circumstances, an experiment was planned by selecting a set of recommended wheat varieties under different sowing environments with enhanced N-levels.

Materials and Methods

A field experiments was conducted during *rabi* 2015-16 and 2016-17 at Research Farm of Agromet Research Centre, SKUAST-Jammu (Latitude $32^0 39^/$ N, longitude $74^0 58^/$ E and altitude 332 m amsl), J&K UT. Three wheat varieties HD 2967, RSP 561 and WH 1105 were sown under three sowing environments 25th October (early), 14th November (normal) and 4th December (late) with three nitrogen levels (100, 125 and 150 kg/ha) and replicated thrice in split split plot design. The soil of the experimental site was sandy clay loam in texture with 62.5% sand, 11.7% silt and 25.8% clay having moderate moisture retention capacity with 7.8 pH, low organic carbon content of 0.38%, low available nitrogen (236.2 kg/ha) and medium in available phosphorus (13.1 kg/ha) and potassium (120.1 kg/ha). Half of the nitrogen along with full dose of phosphorus and potassium was applied at the time of sowing as basal dose. The remaining half of nitrogen was top dressed in two equal splits, *i.e.* at CRI stage and before booting of wheat crop. The recommended dose of P and K was 50:25 kg/ha for wheat crop (as per package and practices of SKUAST-J) and the sources for nitrogen, phosphorus and potassium were urea, diammonium phosphate and muriate of potash, respectively. However, nitrogen was applied as per the treatment combinations. Irrigation was applied as per need of the crop. The meteorological data, *viz.* maximum and minimum temperature for *rabi* 2015-16 and 2016-17 were recorded at Agrometerological Observatory of SKUAST-Jammu situated at about 50 m from the experimental site (Fig. 1).

Results and Discussion

Soil available Nutrients

Wheat varieties had no significant effect on available nitrogen, phosphorus and potassium in soil after harvest of wheat crop. The values of available nutrients were higher in RSP 561 followed by HD 2967 and WH 1105 varieties. That might be due to the fact that RSP 561 variety had less uptake of NPK as compared to other two varieties (Table 1).

Availability of NPK in soil after wheat harvest was significantly affected by various sowing environments. Significantly higher values of available nitrogen, phosphorus and potassium in soil were recorded in late sowing (4th December). However, values observed in early and normal sowings were statistically similar with each other. It may have occurred due to the less yield and uptake in later sowing environments as compared to early sown crop.

At higher doses of nitrogen, the available N content in the soil was observed to be higher than at lower doses of N which might be due to considerable gain of nitrogen content in the soil. The available phosphorus and potassium in the soil was not influenced by varying nitrogen doses but it's residual available content values were slightly lesser than the initial values mainly due to more removal by the crop. Kachroo and Razdan (2006) also recorded the similar findings. Singh and Yadav (2006) also recorded significant difference among different doses of N for available nitrogen in soil after harvest in wheat crop.

Nutrients Uptake

Uptake of nitrogen, phosphorus and potassium in wheat crop was significantly influenced by varieties, sowing environments and N levels in both the crop growing seasons of *rabi* 2015-16 and 201-17. Among the wheat varieties, WH 1105 recorded highest uptake of N, P and K and found to be statistically significant to HD 2967 and RSP 561 varieties. The highest uptake of these nutrients by WH 1105 might be due to vigorous growth and better root system which had helped in adequate supply of these nutrients resulting in higher biological yield coupled with their effective transfer to the ultimate sink *i.e.* the grains of WH 1105 thus leading to significant increase in N, P and K nutrient contents. Similar results were also reported by Kaur *et al*. (2016).

Wheat sowing on 25th October (early) recorded significantly higher nutrients uptake in grain and straw, followed by 14th November (normal) and 4th December (late) sowing with the exception of statistical similar values of potassium uptake in early and normal sowing of wheat both in *rabi* seasons of 2015-16 and 2016-17. The uptake of nutrients decreased as the sowing was delayed from 25th October. These variations in uptake of nutrients may be due to variation in nitrogen content and yield of grain and straw. The higher uptake of nutrients in grain and straw of wheat in early sowing environment may be due to significantly higher biomass production and longer duration of wheat crop. These results are in conformity with the findings of Kaur *et al.* (2010) and Sharma and Gupta (2003).

Application of 150 kg N/ha recorded highest uptake of nutrients in grain and straw during both the years under study. However, uptake of nutrients by grain and straw in 125 and 100 kg N/ha were also significant to each other. Kumar and Yadav (2005) also observed increased uptake of nutrients with 25% higher N over the recommended. It might be due to the reason that availability of N increased in soil as reflected by higher N which resulted in more uptake of nutrients. The higher amount of N increased the nutritional environment and hence forth resulted in more nutrient uptake and also increased the meristematic activities of the plant. Kachroo and Razdan (2006) and Singh *et al*. (1996) also observed the similar results.

Grain and biological yield

Among the varieties, WH 1105 recorded significantly higher grain and biological yield than HD 2967 and RSP 561 varieties. The varieties HD 2967 and RSP 561 were statistically similar to each other (Table 1). The variation in grain and biological yields of these varieties might have happened due to their respective genetic make-ups and yielding ability responsible for expression of their capabilities for grain and biological yields under a given set of environment. The higher grain and biological yields could

also attributed to greater genetic potential with efficient utilization of radiation by leading to production of maximum leaf area and dry matter which in turn results into higher yield attributes. Similar results were also reported by Kaur *et al*. (2016). It also confirmed the findings of Khichar and Niwas (2007).

There was a marked difference in grain and biological yields of wheat crop due to sowing environments. Delayed sowing adversely affected the yield of wheat crop. Under early sown conditions (25th October), significantly higher grain and biological yields were observed which was followed by statistically lower value of yields recorded with normal and late sowings. The reason behind the significant higher yield values in early sowing might be availability of optimum environmental conditions for growth and development of crop which could have enhanced accumulation of photosynthates from source to sink. Similar findings were also reported by Ram *et al*. (2012). Lower grain and biological yield of wheat crop in sowing environments later than 25th October was mainly due to higher temperature during reproductive periods of the crop.

Application of enhanced levels of nitrogen to wheat resulted in significant increase in grain and biological yield of the crop. 25% higher dose of nitrogen (125 kg/ha) recorded significantly higher yield of wheat than recommended (100 kg/ha) and it was at par with 50% higher dose of nitrogen (150 kg/ha). Recommended dose of nitrogen (100 kg/ha) also performed well but the values were significantly lower than other two doses of nitrogen. Greater grain yield of wheat under higher N levels (125 kg/ha) could be traced to adequately N fertilized crop benefitted from higher rates of nitrogen nutrition that might have resulted into a more vigorous and extensive root system of crop leading to increased vegetative growth means for more sink formation and greater sink size, greater carbohydrate translocation from vegetative growth. Malve *et al.* (2017) found the similar findings in wheat crop. Hameed *et al*. (2003) also observed a significant increase in grain yield of wheat at 120 kg N/ha and a further increase in N levels did not enhance the grain yield significantly.

Interaction effect of varieties, sowing environments and N levels on biological yield

WH 1105 proved to be better option in early and normal sowing environments followed by HD 2967 and RSP 561 varieties (Table 2). The biological yield of RSP 561 and HD 2967 varieties performed statistically at par under normal sowing. However, variety RSP 561 performed similarly during early and normal sowing environments with respect to biological yield. Hameed *et al*. (2003) concluded from his study that wheat variety Fakher-Sarhad performed better if it is sown on last week of October. Fayed *et al.* (2015) concluded from experiments on dates and cultivars that Gemmeiza-9 cultivar of wheat is best suited under mediate sowing date (15th November) to maximize bread grain yield of wheat under N-Sinai environmental conditions.

The biological yield of wheat varieties increased significantly with an increase in N level. But in case of early sowing (25th October) the biological yield increased significantly from 100 to 150 kg N/ha. However, in case of normal and late sowing, a significant increase in the biological yield of wheat was upto 125 kg N/ha only and further increase in biological yield of wheat varieties due to enhanced level of nitrogen was not significant (Table 3). The variable response of different varieties may be due to the fact that the varieties have found to differ in their efficiency to applied nitrogen. Kaur *et al*. (2016) also observed that different genotype varies widely in their yield response under different N management. Dagesh *et al.* (2014) also observed a significant difference for interaction effects of nitrogen and sowing dates of wheat.

Table 1: Effect of agronomic manipulations on yield, soil fertility and nutrient uptake in wheat varieties (pooled data of 2 years)

Treatments	Available nutrients (kg/ha)			Nutrient uptake (kg/ha)						Yield (kg/ha)	
	N	P	K	Grain			Straw			Grain	Biological
				N	P	K	N	P	K		
Varieties											
V_1: HD 2967	235.89	12.40	123.02	69.35	12.51	24.92	45.24	9.34	116.87	4280	10390
V_2: RSP 561	243.89	12.03	128.18	66.72	11.70	25.05	45.04	10.56	118.64	4120	10320
V_3; WH 1105	228.14	12.62	118.31	77.94	14.43	27.89	49.72	11.68	129.86	4590	11100
CD (5%)	NS	NS	NS	4.23	0.87	1.56	2.25	0.51	5.83	100	280
Sowing environments											
D_1: 25th October	226.77	11.94	120.50	78.08	14.00	28.15	51.69	11.61	133.80	4780	11730
D_2: 14th November	235.34	12.05	122.93	73.52	13.19	27.20	46.91	10.50	122.07	4480	10810
D_3: 04th December	245.81	13.07	126.08	62.42	11.38	22.52	41.39	9.47	109.50	3720	9290
CD (5%)	14.08	0.62	4.12	3.17	0.58	1.14	1.89	0.42	4.91	140	270
Nitrogen levels (kg/ha)											
N_1: 100% RDN (100 kg N)	218.88	11.08	119.03	66.21	11.88	24.24	44.51	9.91	115.10	4070	10020
N_2: 125% RDN (125 kg N)	233.78	12.36	122.79	72.69	13.18	26.51	47.14	10.43	123.35	4390	10750
N_3: 150% RDN (150 kg N)	255.27	13.40	127.69	75.12	13.50	27.11	48.50	11.25	126.92	4530	11050
CD (5%)	14.04	0.77	3.17	2.24	0.41	0.84	1.35	0.31	3.52	90	190
Initial	236.20	13.10	120.10								

Table 2 : Interaction effect of varieties and sowing environments on biological yield (kg/ha) of wheat (pooled data of 2 years)

Varieties	Sowing environments			
	D_1: 25th October	D_2: 14th November	D_3: 04th December	Mean
V_1: HD 2967	11808	10830	8547	10395
V_2: RSP 561	11068	10522	9372	10321
V_3: WH 1105	12300	11076	9938	11105
Mean	11725	10809	9286	
CD (5%)	428			

Table 3 : Interaction effect of sowing environments and nitrogen levels on biological yield (kg/ha) of wheat (pooled data of 2 years)

Sowing environments	Nitrogen levels			
	N_1: 100 kg/ha	N_2: 125 kg/ha	N_3: 150 kg/ha	Mean
D_1: 25th October	10953	11801	12423	11726
D_2: 14th November	10140	10936	11351	10809
D_3: 04th December	8980	9502	9376	9286
Mean	10024	10746	11050	
CD (5%)	439			

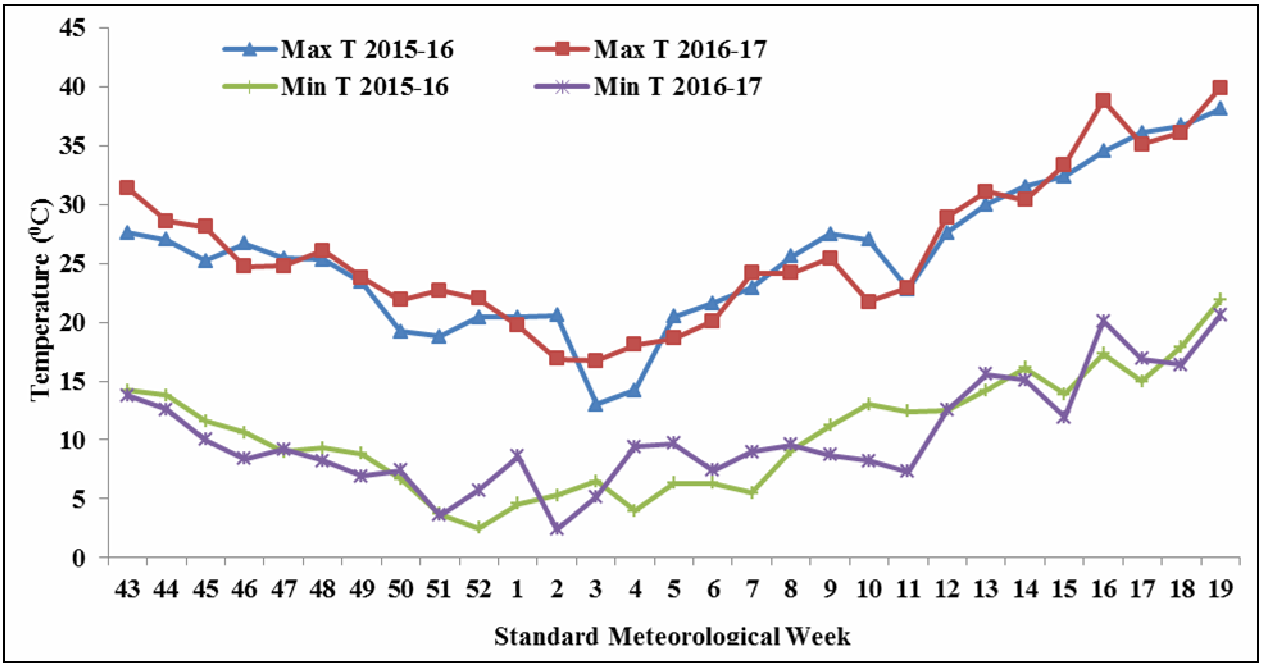

Fig. 1 : Maximum and minimum temperature during *rabi* 2015-16 and 2016-17

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