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Evaluation of wheat genotypes suitable for different nitrogen levels on growth, yield attributes and yield of wheat under rainfed environment in peninsular zone

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Abstract
A field experiment, comprising three nitrogen level viz., 40, 60 and 80 kg/ha and seven wheat genotypes viz., AKDW 2997-16(d), UAS 446(d), HI 8777(d), MACS 4028(d), NI 5439, NIAW 1415 and UAS 375 was conducted at Experimental Research Farm, MACS-Agharkar Research Institute, Hol during 2016-17 to find out better performing genotypes at optimal nitrogen levels in changing climatic condition. The experiment was laid out in randomized completely block design (RCBD) with split plot arrangement comprising of three replications. Under different nitrogen levels, results indicate significant differences among plant height, earheads per m^2, biomass and yield. However, in case of genotypes, all traits were found significant except plant stand count per m^2. The interaction effect of nitrogen levels and genotypes was significant among days to flowering, days to maturity, plant height, TGW, earheads per m^2 and spike length. The maximum earhead per m^2 (305.0), grain (16.7 kg/ha) and biomass yield (50.9 kg/ha) was produced by NI 5439 genotype under 80 kg N/ha. Whereas, the genotype NIAW 1415 showed the maximum spike length (8.9 cm), spikelet per earhead (15.4) and grain per spike (41.1) with 80 kg N/ha. Higher 1000 grain weight was observed by genotype HI 8777 (45.9 g) followed by MACS 4028 (45.8 g) conjunction with 80 N/ha. The higher plant stand count per m^2 was observed by genotype AKDW 2997-16 with no significant difference among different levels of nitrogen. From the study, it was concluded that, the genotypes NI 5439 and UAS 375 produced the maximum grain yield with application of 80 kg N/ha over other nitrogen levels in rainfed condition.

Keywords: Nitrogen level, Wheat, Genotype, Yield, Climate

Introduction
Wheat (*Triticum aestivum* L.) dominates the agronomic crops in terms of production and acreage and occupies an important position in agriculture policies and farming (Shehzad *et al*. 2012a; Shehzad *et al*. 2012b). The world's major dietary sources are cereals because, in most countries, they constitute the main protein and energy supply (Bos *et al*. 2005). Wheat is an important *rabi* season crop of India and Maharashtra with 30.23 m ha and 6.29 lakh ha, of area under wheat cultivation respectively. Productivity of Maharashtra recorded 12.05 q/ha and 30.93 q/ha of India (Anon. 2016). Wheat is an important cereal grain for export and domestic consumption in many countries throughout the world. Thus, continuous supply of wheat to exponentially increasing population is a major concern. Nitrogen occupies a prominent position in plant metabolic processes. Nitrogen is an essential constituent of protein, which is associated with all the vital processes in plants. Therefore, addition of nitrogen in the form of chemical fertilizers is important in order to get maximum crop production. Balanced use of nitrogen is a key point for higher land profitability and healthy environment. Nitrogen is one of the major essential nutrients applied to the crop for higher vegetative growth, productivity and quality (Gwal *et al*. 1999; Ali *et al*. 2000; Iqbal *et al*. 2012). Wheat is one of the most important food crop grown in India under rainfed conditions and it is a challenging task to achieve the potential yield. Among the various factors, which contribute towards productivity, the nitrogen management and selection of suitable genotype is quite important. As the release of new genotypes is a continuous process and the behavior of different genotypes varies under various rate of nitrogen application, therefore, there is a need to generate valuable information on these aspects. Keeping these points under consideration, the present study was planned to assess the performance of various genotypes of rainfed wheat to different levels of nitrogen under rainfed environment in peninsular zone.

Material and Methods
A field experiment was conducted during *rabi* season 2016-17 at Experimental Research

Farm, MACS-Agharkar Research Institute, Hol to assess the performance of various genotypes of rainfed wheat under different levels of nitrogen. The pH of the soil is 8.03, Organic Carbon is 0.49%, and available NPK is 118:9.04:200 kg/ha as well as Sand (%) is 5.7, Silt (%) is 63.4, Clay (%) is 12.8, Na (ME/lit.) is 0.97, calcium (%) is 14.4, Iron (PPM) is 3.3, Magnesium (PPM) is 0.77, Zinc (PPM) is 2.16 and Copper (PPM) is 1.18. The treatments comprising of three levels of nitrogen at 40, 60 and 80 kg ha-1 and seven genotypes i.e. AKDW 2997-16(d), UAS 446(d), HI 8777(d), MACS 4028(d), NI 5439, NIAW 1415 and UAS 375 were randomized completely block design (RCBD) with split plot arrangement comprising of three replications. Gross plot size was 8 meter and 9 row with spacing of 20 cm. The levels of N at 40, 60 and 80 kg ha-1 were designated as N40, N60 and N80, respectively. The wheat varieties under test were sown on 24 October 2016 with row to row spacing of 20 cm and the crop was harvested in date of 16 February 2017. Full dose of N (as per treatment), 30 kg P2O5 and 20 kg K2O ha-1 was applied at the time of sowing. A post-sowing irrigation was given but later on, throughout the season, no irrigation was given to maintain the rainfed conditions.

Results and Discussion

Days to flowering

Days to flowering of wheat was significantly affected by different wheat varieties and the interactive response of varieties and nitrogen while not significantly affected by nitrogen levels (Table 1). Early flowering (57 days) was recorded from wheat variety MACS 4028 while late flowering (65 days) was produced by the variety NIAW 1415 (Table 2). This variation may be due to different genetic make-up of the testing genotypes. Similarly, nitrogen applied at the rate of 40, 60 and 80 kg/ha has produced same day flowering viz, at 62 days means not significant difference between these three nitrogen levels. The interaction V x N showed that increase in nitrogen level at three different levels then it has no more effect on days to flowering. These results are in line with Das and Guha (1998).

Days to maturity

Days to flowering of wheat was significantly affected by different wheat varieties and the interactive response of varieties and nitrogen while not significantly affected by nitrogen levels (Table 1). Early maturity (99 days) was obtained from wheat variety MACS 4028 while late maturity (103 days) were produced by the variety NIAW 1415 and AKDW 2997-16 (Table 2). This variation may be due to different genetic make-up of the testing genotypes. However, nitrogen applied at the rate of 40, 60 and 80 kg/ha has produced same day maturity viz, 102 days means not significant difference between these three nitrogen levels. The interaction of varieties and nitrogen level showed significant that increase in nitrogen level at three different levels then it has no more effect on days to maturity. These results are in line with those of Negi & Gulshan (2000).

Plant height (cm)

Plant height of wheat was significantly affected by different wheat varieties, nitogen levels and interactive response of different wheat varieties and nitrogen levels (Table 1). Analysis of the data revealed that higher plant height (81 cm) was recorded in variety MACS 4028, while comparatively lower plant height were recorded for the varieties AKDW 2997-16, HI 8777 and NIAW 1415 (Table 2). The difference in plant height might be due to different genetical make-up of the varieties. Among nitrogen levels, higher plant height (67) was recorded when nitrogen was applied at the rate of 80 kg/ha while lower plant height (61 and 62 cm) were recorded when nitrogen was applied at the rate of 40 and 60 kg/ha. The finding of Ali *et al*. (2000), Khan *et al*. (2000) and Ali *et al*. (2011), who reported that increasing the level of nitrogen increased the plant height, supported these results.

Thousand grains weight (g)

Thousand grains weight of wheat was significantly affected by different wheat varieties and interactive response of both, while their nitrogen levels was not significant (Table 1). The data showed that higher thousand grains weight (45.9 and 45.8 g) were observed in HI 8777 and MACS 4028 respectively, while lower thousand grains weight were recorded in NI 5439 and NIAW 1415 varieties (Table 2). The increase in thousand grains weight due to the varieties might be due to their genetical make-up. Of nitrogen levels, when was plots treated with 40, 60 and 80 kg of N per hectare had no significant difference in thousand grain weight at these three levels. In fact this trait depend to the no. of ear heads per m2, Its increase augment the competition inter and intra plant, higher rate of nitrogen fertilization leads to higher vegetative growth but decline thousand grain weight. Similar results match with Shah *et al*. (2011).

Plants stand count per m^2

Plant stand count per m^2 of wheat were statistically found non-significant for different wheat varieties, nitrogen levels, and interactive response of different nitrogen and varieties (Table 1). Analysis of the data revealed that higher plant stand count per m^2 (277) was produced in variety AKDW 2997-16, while comparatively lower plant stand count per m^2 were recorded for the varieties NI 5439 NIAW 1415 and HI 8777 (Table 3). The difference in plant stand count per m^2 might be due to different genetical make-up of the varieties. Among nitrogen levels, maximum plant stand count per m^2 (271 and 267) were recorded when nitrogen was applied at the rate of 80 and 60 kg/ha, respectively. The inter action of different varieties and nitrogen level indicated that increase nitrogen level at optimum level with increase plant stand count per m^2 and no more significant difference of plant stand count between these three levels. Similar results were reported by Burnett *et al*. (2003).

Ear head per m^2

Ear head per m^2 of wheat were statistically found significant for different wheat varieties, nitrogen levels and interactive response of different nitrogen and varieties (Table 1). Analysis of the data revealed that higher ear head per m2 (305) was produced in variety NI 5439, while comparatively lower ear head per m2 were recorded for the variety AKDW 2997-16, HI 8777 and NIAW 1415 (Table 3). The difference in ear head per m2 might be due to different genetical make-up of the varieties. Among nitrogen levels, maximum ear head per m2 (267 and 241) was recorded when nitrogen was applied at the rate of 80 and 40 kg/ha respectively. Nitrogen is a primary nutrient required by plants in large quantity for their vegetative growth. The difference in ear head per m2 of wheat, due to application of nitrogen, might be due to the ability of nitrogen to enhance vegetative growth. Similar results were reported by Burnett *et al*. (2003), who concluded that application of nitrogen increase ear head per m^2.

Spike length (cm)

Spike length of wheat was significantly affected by different wheat varieties, interactive response and non-significant by nitrogen levels (Table 1). Spike length was longer (8.9 and 8.3 cm) in varieties NIAW 1415 and UAS 375, while shorter spike length (6.3 cm) was produced by UAS 446 (Table 3). Among nitrogen levels, nitrogen applied at the rate of 80 kg/ha produced longer spike length (7.4) which was followed by 40 and 60 kg/ha but no more significant difference between among these three nitrogen levels. Similar results were reported by Ali *et al* (2012).

Spikelets per earhead

Spikelets per earhead of wheat were significantly affected by different wheat varieties and the interactive response of varieties and nitrogen while not significantly affected by nitrogen levels (Table 1). Higher spikelet per earhead (15.4 and 14.9) was calculated for NIAW 1415 and UAS 375 while lower spikelet per earhead (12.3) was calculated for MACS 4028 (Table 3). This might be due to difference in the genetic make-up of varieties. The interactions of wheat varieties and nitrogen showed that spikelets per earhead increased in NIAW 1415 and UAS 375 with increase in nitrogen application. However, there was no significant differences between 40 and 60 N kg/ha. Similar results Modhej *et al.* (2008), Ali *et al.* (2011) and Iqbal *et al*., (2012). This might be probably due to difference of varieties response to nitrogen.

Grains per spike

Grains per spike was significantly affected by only varieties and had non-significant of nitrogen and interactive response (Table 1). Analysis of the data showed that maximum number of grains per spike (41) was produced in the variety NIAW 1415 while lower number of grains per spike (26, 27) were recorded in MACS 4028 and HI 8777 (Table 4). The probable reason for this is that different varieties have different genetic make-up. Among nitrogen levels, maximum number of grains per spike (33) was produced when nitrogen was applied at the rate of 80 kg/ha while on par number of grains per spike were observed in the rest of the levels. The increase in number of grains per spike might be due to high availability of nitrogen and the crop's efficient use of nitrogen. These results are in line with those of Bakht *et al.* (2010), who reported that addition of different levels of nitrogen to different varieties enhances the number of grains per spike. The interactive effect of varieties and nitrogen levels indicated that grains per spike increased in NIAW 1415 and UAS 375 with increase in nitrogen up to 80 kg/ha while further increase in nitrogen had no effect on grains per spike. Probable reason for this is that different varieties have different genetical potential to use nitrogen efficiently.

Biomass yield (q/ha)

Biomass yield of wheat was significantly affected by different varieties and nitrogen levels and had non-significant of interactive response (Table 1). Higher biomass yield (50.9 q/ha) was obtained from wheat variety NI 5439 and followed by UAS 375, NIAW 1415 and MACS 4028 while lower biological yield (40.5 q/ha) was produced by the variety HI 8777 (Table 4). This variation may be due to different genetic make-up of the testing genotypes. Similarly, nitrogen applied at the rate of 80 kg/ha produced maximum biological yield (48.2 q/ha) while lower biological yield was recorded in the rest plots. The probable reason for this increase in biological yield might be that nitrogen enhanced the vegetative growth, which results in greater biomass. These results are in line with those of (Noy-Meir and Briske, 2002), who suggested that N limitation may contribute to growth suppression and reduction in biomass production. The interaction V x N showed that increasing nitrogen level up to 80 kg/ha increased the biological yield in NI 5439, UAS 375 and NIAW 1415 and further decrease in nitrogen level decreased the biological yield 40, 60 kg/ha respectively. In wheat variety NI 5439, biological yield increased with increase in nitrogen levels. Wheat variety HI 8777 biological yield decreased with increasing nitrogen levels. The probable reason for the interactive response is that different varieties respond differently to nitrogen.

Grain yield (q/ha)

Grain yield of wheat was significantly affected by different wheat varieties and nitrogen levels (Table 1). Grain yield was higher (16.7 and 15.5 q/ha) in varieties NI 5439 and UAS 375, while lower grain yield (11.4 q/ha) was produced by HI 8777. Among nitrogen levels, nitrogen applied at the rate of 80 kg/ha produced maximum grain yield (15.0 q/ha) followed by grain yield (13.5 and 12.5 q/ha) was recorded in the plots treated with 40 and 60 kg of N per hectare (Table 4). This may be due to the optimum requirements of wheat crop in the present study. Similar results were previously reported by Ram *et al.* (2002), who suggested that nitrogen enhanced the grain yield of wheat. The interactive response of varieties and nitrogen indicated that increasing nitrogen level increased grain yield in NI 5439, in case of UAS 375, MACS 4028 and NIAW 1415 grain yield increased with the increase in nitrogen application up to 80 kg/ha while further increase in nitrogen decreased the grain yield in these varieties. This might be due to different varieties have different genetic make-up and hence respond differently to nitrogen.

Table 1: Analysis of variance for different varieties and nitrogen level

Source	Df	Days to flowering	Days to maturity	Plant height (cm)	1000 grain weight (g)	Plant stand count per m^2	Ear heads per m^2	Spike length (cm)	Spike lets per ear head	Grains per spike	Biomass yield (q/ha)	Grain yield (q/ha)
Block	2	1.54	5.349	45.54	2.683	228.968	77.778	0.063	7.635	43	43.68	3.857
MP	2	0.254	1.063	178.587**	0.587	221.825	6209.921**	0.302	1.254	14.714	179.891**	31.116**
Block by MP	4	0.302*	0.706*	3.397*	0.968	453.968*	77.183	0.159	0.349*	16.071*	92.084*	5.252*
SP	6	57.349**	19.397**	709.323**	365.249*	156.217	7754.497**	8.312**	10.497**	233.439*	99.176*	29.503*
Block by SP	12	1.429*	1.238	2.966*	1.701	53.042	806.481**	0.249	0.505*	7.185	6.567	0.567*
MP by SP	12	0.421*	1.397*	18.735**	2.05**	97.288	246.958*	0.209*	1.735*	4.011	10.015	1.336
Residual	24	0.524	1.179	4.045	0.931	146.792	271.858	0.288	1.553	4.507	8.711	1.259

Table 2: Effect of different wheat varieties and nitrogen levels on days to flowering, days to maturity and plant height

Treatment/variety	AKDW 2997-16	HI 8777	MACS 4028	NI 5439	NIAW 1415	UAS 375	UAS 446	Mean
Days to flowering								
N1	62.0	61.7	57.0	61.3	65.3	61.3	62.7	61.6
N2	62.7	60.7	56.7	61.0	65.3	62.0	63.0	61.6
N3	62.7	61.3	57.0	61.7	65.3	62.3	62.3	61.8
Mean	62.4	61.2	56.9	61.3	65.3	61.9	62.7	
LSD for MP = 0.3613			LSD for SP = 0.5837			LSD for MP*SP = 1.0110		
Days to maturity								
N1	103.7	101.0	99.3	101.0	102.7	102.0	101.3	101.6
N2	102.3	100.7	99.7	100.3	102.7	103.3	102.7	101.7
N3	103.3	100.0	99.0	101.7	104.0	103.0	103.0	102.0
Mean	103.1	100.6	99.3	101.0	103.1	102.8	102.3	
LSD for MP = 0.5529			LSD for SP = 0.8756			LSD for MP*SP = 1.5165		
Plant height (cm)								
N1	53.3	54.7	78.7	71.0	55.0	62.3	62.0	62.4
N2	54.0	55.0	78.3	65.0	55.0	63.0	59.7	61.4
N3	61.7	61.0	85.7	66.3	57.3	66.3	70.0	66.9
Mean	56.3	56.9	80.9	67.4	55.8	63.9	63.9	
LSD for MP = 1.2125			LSD for SP = 1.6221			LSD for MP*SP = 2.8095		
1000 grain weight (g)								
N1	38.7	45.7	46.3	31.0	31.7	32.0	37.7	37.6
N2	37.0	45.7	46.3	29.3	31.0	34.0	37.3	37.2
N3	37.0	46.3	44.7	30.7	32.3	33.3	37.7	37.4
Mean	37.6	45.9	45.8	30.3	31.7	33.1	37.6	
LSD for MP = 0.6474			LSD for SP = 0.7783			LSD for MP*SP = 1.3480		

Table 3: Effect of different wheat varieties and nitrogen levels on plant stand, ear head, spike length and spikelets per ear head

Treatment/variety	AKDW 2997-16	HI 8777	MACS 4028	NI 5439	NIAW 1415	UAS 375	UAS 446	Mean
Plant stand count per m^2								
N1	273.3	265.0	266.7	265.0	258.3	265.0	261.7	265.0
N2	281.7	263.3	261.7	271.7	260.0	271.7	261.7	267.4
N3	275.0	271.7	273.3	260.0	278.3	271.7	270.0	271.4
Mean	276.7	266.7	267.2	265.6	265.6	269.4	264.4	
LSD for MP = 14.0176			LSD for SP = 9.7716			LSD for MP*SP = 16.9249		
Ear head per m^2								
N1	206.7	216.7	228.3	286.7	225.0	226.7	258.3	235.5
N2	215.0	228.3	236.7	290.0	228.3	241.7	246.7	241.0
N3	221.7	255.0	250.0	338.3	246.7	273.3	288.3	267.6
Mean	214.4	233.3	238.3	305.0	233.3	247.2	264.4	
LSD for MP = 5.7799			LSD for SP = 13.2980			LSD for MP*SP = 23.0328		
Spike length (cm)								
N1	7.0	6.7	6.3	7.7	9.0	8.7	6.0	7.3
N2	7.0	6.7	6.7	7.0	8.7	8.0	6.3	7.2
N3	6.7	7.0	6.7	7.7	9.0	8.3	6.7	7.4
Mean	6.9	6.8	6.6	7.4	8.9	8.3	6.3	
LSD for MP = 0.2621			LSD for SP = 0.4331			LSD for MP*SP = 0.7501		
Spikelets per ear head								
N1	14.0	12.7	11.7	14.0	14.0	14.3	14.0	13.5
N2	13.3	12.3	12.7	14.0	16.0	15.0	13.7	13.9
N3	13.3	14.0	12.7	14.0	16.3	15.3	12.3	14.0
Mean	13.6	13.0	12.3	14.0	15.4	14.9	13.3	
LSD for MP = 0.3888			LSD for SP = 1.0050			LSD for MP*SP = 1.7408		

Table 4: Effect of different wheat varieties and nitrogen levels on grains per spike, biomass and grain yield

Treatment/ variety	AKDW 2997-16	HI 8777	MACS 4028	NI 5439	NIAW 1415	UAS 375	UAS 446	Mean
Grains per spike								
N1	31.0	26.3	26.2	33.2	41.3	34.6	31.3	32.0
N2	33.0	26.7	25.3	33.7	41.7	33.7	28.3	31.8
N3	34.0	29.0	27.3	35.3	40.3	37.3	30.0	33.3
Mean	32.7	27.3	26.3	34.1	41.1	35.2	29.9	
LSD for MP = 2.6375			LSD for SP = 1.7121			LSD for MP*SP = 2.9655		
Biomass (q/ha)								
N1	39.5	37.8	42.4	46.1	45.4	41.6	43.7	42.4
N2	42.2	39.2	46.6	50.0	44.9	45.9	43.2	44.6
N3	44.9	44.4	46.3	56.6	47.7	51.0	46.2	48.2
Mean	42.2	40.5	45.1	50.9	46.0	46.1	44.4	
LSD for MP = 6.3133			LSD for SP = 2.3804			LSD for MP*SP = 4.1230		

Grain yield (q/ha)								
N1	11.3	9.9	12.5	14.7	12.7	14.2	12.3	12.5
N2	12.6	11.4	13.9	16.3	12.8	15.9	11.7	13.5
N3	14.3	13.0	14.6	19.0	14.2	16.3	13.3	15.0
Mean	12.8	11.4	13.6	16.7	13.2	15.5	12.4	
LSD for MP = 1.5078			LSD for SP = 0.9050			LSD for MP*SP = 1.5676		

Conclusion
From the above investigation, it is concluded that the genotypes NI 5439 and UAS 375 were suitable under rainfed environment with higher dose of nitrogen i. e. 80 kg/ha for producing maximum grain yield under Peninsular Zone. Whereas, the genotypes UAS 375 and MACS 4028 producing maximum yield with optimum dose of nitrogen i. e. 60 kg/ha under rainfed environment.

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