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Effect of different FYM and nitrogen levels on productivity of barley (*Hordeum vulgare* L.)

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Abstract
The present experiment was conducted for evaluated the combined effect of organic manure (FYM) and inorganic fertilizers (Nitrogen) doses on the growth and yield of barley. The experiment consist twelve treatment included three levels of FYM (FYM_0 = 0 t/ha, FYM_1 = 3 t/ha, FYM_2 = 6 t/ha) and four levels of nitrogen (N_0 = 0 kg/haN_1 = 50% RDNN_2 = 75% RDN, N_3 = 100% RDN) in a Randomized Block Design (RBD) with three replications. Maximum value of growth parameters and yield attributes characters was observed with 6 t FYM ha^{-1} and 100% RDN ha^{-1} levels. Maximum grain yield (4213.9 kg ha^{-1}) was also recorded with 6 t FYM ha^{-1} which was 18.8 and 6.0 per cent significantly higher to control and 3 t FYM ha^{-1} levels. Application of nitrogen significantly affected the grain and biological yield as well as harvest index of barley. Under different treatment combination (interactions) of FYM and nitrogen, maximum B:C ratio (2.93) was obtained from FYM_1 x N_3 followed by FYM_2 x N_3 with 2.89 B:C ratio. Whereas minimum B:C ratio (2.44) under control of both parameters (FYM_0 x N_0).

Keywords: Barley, B:C ratio, FYM, nitrogen

Introduction
Barley (*Hordeum vulgare* L.) belonging to Poaceae family, is one of the most important staple food crops in the world. It is the world's 4th most essential cereal crop after wheat, rice and maize with a share of about 7% of the global cereals production and 15% of coarse grains consumption. Barley is grown throughout the temperate, tropical and subtropical regions of the world and can be successfully grown in adverse climatic conditions of drought, salinity and alkalinity due to its wide adaptability (Chavarekar *et al*., 2013) [4]. Barley is superior to wheat as both grains and straw are highly digestible due to the absence of gluten. In the world, barley crop covers an area of 49.56 m ha with production 149.48 m t and productivity of 2856 kg ha^{-1}, respectively during 2019-20. In India, barley is mainly grown in Rajasthan, Uttar Pradesh, Punjab and Haryana besides the minor quantities at other places with the area of 0.59 million hectares, 1.5 million tons production and 2478 kg ha^{-1} productivity in the year 2019-20 (Anonymous, 2020) [1]. The chemical fertilizers no doubt are important sources which can meet then nutrient requirement but their imbalanced and continuous use lead to deterioration of Physico-chemical properties. The combined use of organic and inorganic fertilizers not only increases the crop yield but also improve the physical and biological properties of soil (Raghuwanshi *et al.*, 1988) [10]. Among the nutrients, nitrogen plays an important role in barley production. Low level of nitrogen results in lower yield and higher level of nitrogen causes environmental pollution and also increases cost of cultivation. Indian soils are deficient in nitrogen. Deficiency of this major element is a limiting factor in crop production in this country. It is, therefore, required to be added in appropriate quantity to the soil. Organic manuring and nitrogen fertilization are considered among the most important cultural practices for increasing barley productivity and improved quality parameters. In crop production, nutrient availability from manure has been recognized for many centuries (Chavarekar *et al.*, 2013) [4]. Keeping above facts, the present experiments was carried out to determine the effects of combined application of farmyard manure (FYM) with inorganic nitrogen on yield components, yield of barley.

Material and Methods
The present experiment was conducted during the *Rabi* season of 2020-21 at experimental farm, school of Agriculture, ITM University Gwalior, Madhya Pradesh to evaluated the combined effect of organic manure (FYM) and inorganic fertilizers (Nitrogen) doses on the growth and yield of barley.

The soil of the experimental site was Sandy Clay Loam in texture, low in available nitrogen and medium in phosphorus and potassium. After the layout of field, required quantity of FYM (as per treatments) was mix in the soils. Barley variety (Cv. NDB-1175) was sown at the rate of 100 kg ha^{-1} seed with 20 x 05 cm spacing of row to row and plant to plant on November 30, 2020. The experiment consist twelve treatment included three levels of FYM (FYM_0 = 0 t/ha, FYM_1 = 3 t/ha, FYM_2 = 6 t/ha) and four levels of nitrogen (N_0 = 0 kg/haN_1 = 50% RDNN_2 = 75% RDN, N_3 = 100% RDN). All the treatments replicated thrice in a Randomized Block Design (RBD) with factorial concept. All other agronomic practices except those under study were kept normal and uniform for all the treatments. The cost of production in each treatment was worked out by considering the prevailing market price of input and the produce (grain and straw). The net income was calculated by subtracting the cost of cultivation from gross monetary returns (Rs ha^{-1}).

Result and Discussion

Effect of FYM on growth, yield attributes and yield of barley: The results revealed that (Table-1) the application of FYM significantly increased the growth parameters (i.e. plant height, number of tillers $plant^{-1}$ and number of leaves) and yield attributes characters (i.e. length of ear-head, grains $ear\text{-}head^{-1}$ and test weight) of barley under present study. Maximum value of growth and yield attributes was recorded with 6 t FYM ha^{-1} which was significantly higher to control and 3 t FYM ha^{-1} treatment. The enhanced early vegetative growth in terms of height leaves and vigorous root system resulted in more longer and thicker ear-head which consequently increased the number of grains $ear\text{-}head^{-1}$ significantly. Maximum length (7.37 cm) of ear-head and test weight (33.41 g) was observed with 6 t FYM ha^{-1} which was significantly higher to control and 3 t FYM ha^{-1} levels. This might be due to the fact that FYM acted as nutrient reservoir and upon decomposition produced organic acids thereby absorbed irons are released slowly for the entire crop growth leading to higher plant height. FYM worked as soil conditioner in addition to supplying plant nutrients and resulted in improvement in plant height at different stages of plant growth (Prasad, 1994) and adequate supply of all the nutrients through FYM, resulted in greater accumulation of carbohydrates, amino acids and their translocation to the productive organs, which, in-turn improved all the growth and yield attributing characters. Results confirm the finding Nayak *et al.* (2001) [8] and Kumar *et al*. (2014) [7].

It is evident from result (Table-2), that the increasing level of FYM up to 6 t ha^{-1} significantly increased the grain and straw yield of barley. Maximum grain (4213.9 kg ha^{-1}) and straw yield (5538.9 kg ha^{-1})was observed with 6 t FYM ha^{-1}in which grain yield was 18.8 and 6.0 per cent significantly higher to control and 3 t FYM ha^{-1} levels. The increase in grain and biological yield might be due to adequate quantities and balanced proportions of plant nutrients supplied by FYM to the crop as per need during the growth period resulting in favourable increase in yield attributing characters which ultimately led towards an increase in economic yield. The findings confirm the results of Brar *et al*. (2001) [2] and Khadtare *et al.* (2006) [5].

Table 1: Effect of FYM and nitrogen levels on growth and yield attributes parameters of barley

Treatments	Growth parameters			Yield attributes parameters		
	Plant height (cm)	Number of Leaves/clum	Number of tillers/plant	Length of Earhead(cm)	Number of Grains/earhead	Test weight (g)
FYM Level – 3						
FYM_0: 0 tha^{-1}	86.26	19.01	13.07	6.04	28.40	30.67
FYM_1 : 3 t ha^{-1}	92.43	21.00	14.99	6.84	30.76	32.18
FYM_2 : 6 t ha^{-1}	95.28	21.27	16.34	7.37	31.98	33.41
S.E m.±	0.99	0.39	0.26	0.10	0.49	0.29
C.D. (5%)	2.91	1.13	0.77	0.29	1.45	0.84
Nitrogen Level - 4						
N_0 =Control	82.60	17.27	12.73	5.76	27.76	30.20
N_1 = 50% RDN	89.52	19.87	14.57	6.48	29.81	31.28
N_2 = 75% RDN	94.51	21.41	15.55	7.17	31.33	33.20
N_3 = 100% RDN	98.65	23.17	16.36	7.59	32.62	33.67
S.E m.±	1.14	0.44	0.30	0.11	0.57	0.33
C.D. (5%)	3.36	1.31	0.89	0.33	1.67	0.98
Interaction(FYM xN)	NS	NS	NS	S*	NS	NS

Table 2: Yield and economical parameters of barley as influenced by different treatments of FYM and nitrogen levels

Treatments	Yield(kg ha^{-1})		Cost of cultivation Rs. ha^{-1})			Return (Rs. ha^{-1})		B : C ratio
	Grain	Straw	Excluding treatments	Treatment cost	Total	Gross *	Net	
FYM Level– 3								
FYM_0: 0 tha^{-1}	3547.2	5101.6	23095	0	23095	61139	38044	2.65
FYM_1 : 3 t ha^{-1}	3975.8	5372.5	23095	1500	24595	67749	43154	2.75
FYM_2 : 6 t ha^{-1}	4213.9	5538.9	23095	3000	26095	71457	45362	2.74
S.E m.±	54.4	46.5	-	-	-	-	-	-
C.D. (5%)	159.52	136.47	-	-	-	-	-	-
Nitrogen Level - 4								
N_0 : 0 kg/ha	3458.5	5009.7	23095	0	23095	59691	36596	2.58
N_1 : 50% RDN	3828.8	5300	23095	424	23519	65528	42009	2.79
N_2 : 75% RDN	4051.5	5371.2	23095	636	23731	68806	45075	2.90
N_3 : 100% RDN	4310.4	5669.9	23095	848	23943	73103	49160	3.05

S.E m.±	62.8	53.7	-	-	-	-	-	-
C.D. (5%)	184.2	157.6	-	-	-	-	-	-
Treatment combination								
T_1 : FYM_0 N_0	3233.1	4890.9	23095	0	23095	56268	33173	2.44
T_2 : FYM_0 N_1	3457.0	4931.7	23095	424	23519	59494	35975	2.53
T_3 : FYM_0 N_2	3613.8	5036.1	23095	636	23731	61924	38193	2.61
T_4 : FYM_0 N_3	3885.1	5547.9	23095	848	23943	66874	42931	2.79
T_5 : FYM_1 N_0	3488.0	5031.6	23095	1500	24595	60153	35558	2.45
T_6 : FYM_1 N_1	3829.4	5339.6	23095	1924	25019	65626	40607	2.62
T_7 : FYM_1 N_2	4167.7	5497.9	23095	2136	25231	70718	45487	2.80
T_8 : FYM_1 N_3	4418.2	5621.0	23095	2348	25443	74502	49059	2.93
T_9 : FYM_2 N_0	3654.5	5106.6	23095	3000	26095	62653	36558	2.40
T_{10} :FYM_2 N_1	4200.1	5628.6	23095	3424	26519	71466	44947	2.69
T_{11} :FYM_2 N_2	4373.1	5579.7	23095	3636	26731	73778	47047	2.76
T_{12} :FYM_2 N_3	4627.9	5840.8	23095	3848	26943	77932	50989	2.89

Effect of nitrogen on growth, yield attributes and yield of barley: The application of nitrogen significantly increased the growth parameters (i.e. plant height, number of tillers plant^{-1} and number of leaves) and yield attributes characters (i.e. length of ear-head, grains ear-head $^{-1}$ and test weight) of barley in present study. Maximum value of growth and yield attributes was recorded with 100% RDN ha^{-1} which was significantly higher to control and lower levels of nitrogen i.e. 50 and 75% RDN treatments. Maximum length (7.59 cm) of ear-head and test weight (33.67 g) was observed with 100% RDN ha^{-1} which was significantly higher to control and lower levels of nitrogen i.e. 50 and 75% RDN treatments. The findings confirm the results of Khan *et al.* (2011) [6], Chauhan and Yadav (2012) [3] and Neelam *et al.* (2018) [9].

The application of 100% RDN ha^{-1} recorded significantly maximum grain yield (4310.4 kg ha^{-1}) which was 24.6, 12.6 and 6.4 per cent significantly higher as compared to control and lower levels of nitrogen i.e. 50 and 75% RDN treatments. The increase in grain and straw yield with the application on nitrogen might be due to the dual benefits of improving adequate supply of available plant nitrogen. The increased tiller production might also be due to the narrow C: N ratio in which helped immediate release of plant nutrients from FYM (Khadtare *et al.*, 2006) [5].

Effect of FYM and nitrogen on economics

It is revealed from results (Table-2), that the maximum gross and net return was obtained from FYM_2 (6 t FYM ha^{-1}), N_3 (100% RDN ha^{-1}) treatment and FYM_2 x N_3 combination and it was higher than all other treatments. Under different treatment combination (interactions) of FYM and nitrogen, maximum B:C ratio (2.93) was obtained from FYM_1 x N_3 followed by FYM_2 x N_3 with 2.89 B:C ratio. These results are similar to yield of crop obtained from different treatments and confirm to the findings of Sahoo and Panda (2000) [11] and Khadtare *et al.* (2006) [5]. The net returns and benefits obtained were less in higher levels of FYM (6 t FYM ha^{-1}) as compared to lower levels (3 t FYM ha^{-1}) due to the high cost of FYM. The additional cost of FYM was not compensated by the additional yield of barley. Under different levels of nitrogen, maximum B:C ratio (3.05) was obtained from N_3 (100% RDN ha^{-1}) followed by N_2 (75% RDN ha^{-1}) with 2.90 B:C ratio. Results confirm the finding of. Neelam *et al.* (2018) [9] who found maximum Net returns (45732) and B:C ratio (2.40) were achieved when 100% RDN was applied.

Conclusion

From present study, it can be concluded that application of 100% RDN (60 kg N ha^{-1}) along with 3 to 6 t FYM ha^{-1} produced higher economic yield of barley. This gave highest net returns and benefit cost ratio in barley in Sandy Clay Loam soil of Gwalior district of Northern Madhya Pradesh.

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