

## Effect of level and time of nitrogen application with and without vermicompost on yield, yield attributes and quality of malt barley (*Hordeum vulgare*)

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### ABSTRACT

A field experiment was conducted during the winter (*rabi*) season of 1998–99 and 1999–2000 at Hisar, to determine the impact of N fertilizer applied at different growth stages, with and without vermicompost on yield components, grain yield and malting quality of barley (*Hordeum vulgare* L., s.l.) in the first trial and to study the effect of different levels of nitrogen and phosphorus with and without vermicompost on yield and nutrient uptake by barley in the second. Nitrogen application significantly enhanced the grain and straw yields up to 90 kg N/ha. All the yield components, grain yield and nutrient uptake attained their maximum value with 10 tonnes/ha vermicompost. The grain and malt quality of barley was also influenced significantly with the application of vermicompost and nitrogen levels. The result indicated that N fertilizer strategies for malting barley should ensure relatively small amount of available one-third N at sowing for crop establishment and initial tiller development. Additional one-third N would then be applied at first irrigation (35 days after sowing) and one-third N at flowering (70 days). The highest grain yield and nutrient uptake were recorded with  $N_{90}P_{30}$  level of fertility.

**Key words :** Malt barley, INM, Vermicompost, Malt quality, Nutrient uptake, Fertility level

Use of vermicompost is being advocated for sustaining soil fertility in various field crops. In vermicomposting, beneficial soil bacteria along with earthworms are involved as the prime work force to process the organic wastes. These are 10 times faster in their work compared to bacteria and fungi associated with the process of composting. Fertilizer level and time of its application also affects the grain yield and quality. Insufficient nitrogen can reduce grain yield and quality below acceptable levels, while excess nitrogen usually produces undesirable high protein levels (Lauer and portridge, 1990). Keeping the above facts in view, field trials were carried out to evaluate the yield, yield attributes and quality of malt barley as affected by different levels of nitrogen and vermicompost with different times of nitrogen application in the first trial and to study the effect of different levels of nitrogen and phosphorus with and without vermicompost on grain yield and nutrient uptake by barley in the second.

### MATERIALS AND METHODS

Two field trials were conducted during the winter (*rabi*) season of 1998–99 and 1999–2000 at Agronomy Research Farm, CCS Haryana Agricultural University, Hisar, on sandy-loam soil, with pH 7.9. The soil of the experimental field was low in organic carbon (380.7%)

and available nitrogen (147.50 kg/ha), medium in available phosphorus (14.43 kg/ha), high in available potash (380.7 kg/ha) and slightly alkaline in reaction. Vermicompost contained nitrogen (1.36, 1.35); phosphorus (0.56, 0.55); potassium (1.14, 1.15); calcium (0.45, 0.47) and C: N ratio (23.8, 24.2) in percentage during both the years respectively. The variety used was 'BH 393'. The first trial was laid out in split-plot design with 2 levels of vermicompost (0 and 10 tonnes/ha) and 4 levels of nitrogen (0, 30, 60 and 90 kg/ha) in main plot treatments and 3 times of nitrogen application ( $T_1$ , full N at sowing,  $T_2$ , half N at sowing + half N at first irrigation, i.e. 35 days after sowing,  $T_3$ , and 1/3 N at sowing + 1/3 N at first irrigation, i.e. 35 days after sowing + 1/3 N at flowering, i.e. 70 days after sowing) in subplot treatments. Malt yield was obtained by automatic micromalting system. The second trial was laid out in randomized block design (factorial), replicated thrice. The treatments comprised levels of vermicompost (0 and 10 tonnes/ha) and 4 levels of fertility ( $N_0P_0$ ,  $N_{30}P_{30}$ ,  $N_{60}P_{30}$ ,  $N_{90}P_{30}$  in kg/ha).

### RESULTS AND DISCUSSION

#### Effect of vermicompost

Higher number of productive tillers, panicle length, filled grains and test weight were recorded with 10 tonnes/

ha vermicompost. This was owing to microbial stimulation effect of vermicompost and N supplied through gradual mineralization in steady manner. Application of vermicompost increased the grain yield of malt barley significantly over the control. This may be owing to continuous and steady supply of available nitrogen to match the uptake pattern of different physiological growth phases of barley. Increased supply of nitrogen through vermicompost resulted in greater absorption and utilization, which resulted in better growth of barley having direct bearing on the yield attributes as well as the grain yield. The straw yield was significantly higher with 10 tonnes/ha vermicompost over the control. In the second trial, vermicompost @ 10 tonnes/ha recorded the highest N, P and K uptake. Increased nutrient uptake was mainly owing to improved growth and yield parameters with application of vermicompost. Significant increase in nutrient content in greengram plant was also observed due to addition of vermicompost over the control by Rajkhowa *et al.* (2000). Vermicompost application resulted in higher quality. Significant increase in protein content of grain with vermicompost application was observed. The starch content in grain, fertilized with nitrogen and vermicompost application followed the trend reverse to protein content. Application of vermicompost significantly decreased the malt yield. High malt yield value is normally associated with low protein content in the grain. Malt yield is a key quality indicator because it reflects the amount of beer that can be produced from a given quantity of malt. Ewertson (1997) also reported that there was a strongly negative correlation between protein content and malt yield.

### Effect of N levels

Ears/m, ear length and grains/ear increased significantly with an increase in dose of nitrogen. There was a significant increase in grain yield of malt barley up to 90 kg N/ha. Based on pooled analysis there was 29.51, 53.77 and 70.49% increase in grain yield of malt barley with 30, 60 and 90 kg N/ha application over the control respectively. A similar increase in straw yield over the control respectively as grain yield was observed. Protein content in grain followed a significant increase with the application of 30, 60 and 90 kg N/ha over the control. The minimum starch was contained in grain having maximum protein with 90 kg N/ha. Starch content of barley grain was significantly reduced with increased application of nitrogen, which

**Table 2.** Interaction effect of nitrogen and vermicompost on grain yield (q/ha) of malt barley

Vermicompost (tonnes/ha)	Nitrogen (kg/ha)			
	0	30	60	90
0	28.6	36.7	45.0	50.2
10	32.3	42.2	48.9	53.7
CD (P=0.05)	3.6			

**Table 3.** Interaction effect of nitrogen and its time of application on grain yield (q/ha) of malt barley

Time of N application	Nitrogen (kg/ha)			
	0	30	60	90
T <sub>1</sub>	32.0	36.7	40.6	45.5
T <sub>2</sub>	33.5	39.8	45.2	50.4
T <sub>3</sub>	34.0	42.0	49.8	54.2
CD (P=0.05)		4.8		

**Table 1.** Effect of levels of vermicompost and nitrogen and time of nitrogen application on yield attributes, grain yield, straw yield and quality characters of malt barley (pooled data of 2 years)

Treatment	Ears/m	Ear weight (g)	Ear length (cm)	Grains/ear	Test weight (g)	Yield (q/ha)		Protein content (%)	Starch content (%)	Malt yield (%)
						Grain	Straw			
<i>Vermicompost (tonnes/ha)</i>										
0	70.1	3.1	12.4	58.4	45.3	40	67	7.7	62.0	89.0
10	75.4	3.5	14.6	64.0	47.7	44	71	8.3	60.9	86.1
CD (P=0.05)	2.9	0.1	0.3	1.7	0.7	1	02	0.2	0.8	1.9
<i>Nitrogen (kg/ha)</i>										
0	56.4	2.8	11.3	54.9	44.3	30	51	7.4	63.0	89.6
30	71.7	3.2	12.8	60.2	46.2	39	65	8.0	61.2	87.2
60	79.1	3.4	14.1	64.3	47.2	46	77	8.2	59.9	86.4
90	84.0	3.6	14.6	65.5	48.4	52	83	8.4	58.3	84.9
CD (P=0.05)	4.2	0.2	1.0	2.5	2.8	2	3	0.4	1.0	2.6
<i>Time of N application</i>										
T <sub>1</sub>	72.9	3.2	12.8	60.0	45.9	38	63	7.9	61.1	88.0
T <sub>2</sub>	75.9	3.3	13.3	61.4	46.6	42	70	8.0	60.9	86.5
T <sub>3</sub>	77.7	3.3	13.5	62.3	47.0	45	73	8.1	60.6	86.2
CD (P=0.05)	2.5	0.1	0.4	1.3	NS	3	2	0.2	NS	1.5

**Table 4.** Effect of vermicompost and fertility levels on yield of malt barley and total nutrient uptake (pooled data of 2 years)

Treatment	Yield (q/ha)		Nutrient uptake (kg/ha)		
	Grain	Straw	N	P	K
<i>Vermicompost (tonnes/ha)</i>					
0	40	55	68.5	14.4	21.7
10	45	61	79.1	16.4	26.2
CD (P=0.05)	02	02	5.3	0.8	3.8
<i>Fertility (kg/ha)</i>					
N <sub>0</sub> P <sub>0</sub>	30	38	47.5	10.0	14.8
N <sub>30</sub> P <sub>30</sub>	39	53	67.0	14.3	21.8
N <sub>60</sub> P <sub>30</sub>	47	65	83.8	17.8	27.6
N <sub>90</sub> P <sub>30</sub>	52	73	96.8	20.4	32.5
CD (P=0.05)	3	3	6.2	1.0	3.9

was detrimental to malting quality of barley grain. Basan and Moravick (1977) also observed an adverse effect of nitrogen application on starch content of grain. Application of nitrogen significantly decreased the malt yield.

#### Effect of fertility levels

In the second trial, the maximum increase in grain and straw yield with N<sub>90</sub>P<sub>30</sub> fertility levels over the control was 75.84 and 93.42% respectively. The increase in grain yield with N<sub>30</sub>P<sub>30</sub> and N<sub>60</sub>P<sub>30</sub> levels of fertility over control was 32.55 and 57.72% respectively. The increase in straw yield with N<sub>30</sub>P<sub>30</sub> and N<sub>60</sub>P<sub>30</sub> levels of fertility over the control was 40.79 and 72.37%, respectively. The N, P and K uptake by grain as well as straw were significantly higher with the application of N<sub>90</sub>P<sub>30</sub> fertility level over lower levels of fertility.

#### Effect of N application time

Effective tillers/m, ear weight and grains/ear increased significantly with split application of N; however, time of N application could not influence the test weight of malt barley. Time of N application also resulted in a significant increase in grain and straw yields and recorded the maximum value with 3 splits. Two and three split applications of N showed 9.88% and 15.54% increase in grain yield over the control respectively. Ramos *et al.* (1995) also reported that nitrogen applied at sowing increased number of tillers/plant, and N applied at tillering favoured tiller survival for later spike formation. In addition, N applied at tillering increased leaves/plant, leaf area/plant and leaf-area index, the maximum value of which occurred at anthesis which ultimately led to higher grain production. Split application of N also influenced the protein content of grain significantly and attained a maximum value when nitrogen was split thrice. The starch content of barley grain decreased steadily with the split application of N, though the difference among treatments was non-significant. Time of nitrogen application also affected the malt yield signifi-

cantly and attained a minimum value with 3 splits of N.

#### Interaction effect

Vermicompost and nitrogen interaction revealed that application of vermicompost resulted in a significant increase in grain yield under all the levels of nitrogen over no-vermicompost application. Under constant level of vermicompost, each successive increase in nitrogen dose resulted in a significant increase in grain yield over preceding level. Application of 90 kg N/ha with 10 tonnes/ha resulted in highest grain yield which was at par with 90 kg N/ha alone.

Interaction effect of nitrogen levels and its time of application indicated that application of 90 kg N/ha without split application recorded almost similar grain yield to 30 kg N/ha with 3 split application of N and 90 kg N/ha without splitting also recorded similar yield of 60 kg N/ha with 2 split application of N. Three splits of 90 kg N/ha recorded the maximum grain yield.

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