INTERNATIONAL JOURNAL OF AGRICULTURE & BIOLOGY
1560–8530/2003/05–4–432–434
http://www.ijab.org

Impact of Cultural Practices on Yield Variability of Semiarid Wall Barley (*Hordeum murineum* L.)

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ABSTRACT

Wall barley (*Hordeum murineum* L.) is the dominant species in northeastern rangeland of Jordan. Field experiments were conducted during the winter seasons of 1999-2000 and 2000-2001 at the semi-arid region in north of Jordan, to study the effect on yield responses of wall barley (*Hordeum murineum* L.) of the following: seeding dates (1, 14 and 28 Dec.), seeding rates (200, 250 and 300 plants m^{-2}), phosphorus levels (40, 60 and 80 kg P ha^{-1}) and two methods of P placement {placed with the seed while sowing 6-cm deep (banded) or spread over the soil surface and incorporated into the top 2-cm of soil before sowing (broadcast)}. Seeding rate, seeding date, and rate of phosphorus had a significant effect on most of the measured traits and the yield components. In general, the results revealed that combination of early seeding (1 Dec.), high seeding rate (300 plant m^{-2}), and P application (80 kg P ha^{-1}) drilled with the seed after cultivation (banded) are promising in obtaining maximum yield of wall barley.

Key Words: Wall barley; Seeding rate; Seeding date; Phosphorus

INTRODUCTION

Jordanian grassland is located within the 200 to 350 mm rainfall zone of the eastern Mediterranean region. This semi-arid rangeland occupies an important part of the country and needs to be well understood to achieve optimum management. Vegetation dynamics and seasonal growth patterns need special attention as many plant communities are exposed to long term overgrazing (El-Shatnawi *et al*., 1999). Wall barley (*Hordeum murineum* L.) is an annual native grass that is the key species for many local plant communities in semiarid rangelands. Wall barley withstands the harsh climatic conditions of dry areas by its ability to reproduce readily from seed and to recover quickly from drought events (El-Shatnawi *et al*., 1999). Previous studies with different cereals have shown that time of sowing (Hopkinson, 1975; Tawaha *et al*., 2001; Turk & Tawaha, 2002), seeding rates (Mcloed, 1982; Fukai *et al*., 1990; Mcdonald, 1990; Dofing & Knight, 1992; Henson & Lukach, 1992), and rates and methods of applying phosphorus fertilizer (Turk, 1998; Tawaha, 2000) having varying effects on different crop parameters. In addition, soil test phosphorus values are typically low for calcareous soils in the Mediterranean region (Kassam, 1981; Cooper, 1983; Harmsen, 1984). Calcareous soils comprise most soils used for agriculture in northern Jordan for which there are limited or no published data for all these factors for *Hordeum murineum*.

This paper describes the effects of sowing date, seeding rate, rate and method of fertilizer phosphorus applications on the production of *Hordeum murineum* on alkaline soils of northern Jordan.

MATERIALS AND METHODS

Location of the trial. The experiments were conducted from 1999 to 2001in northern Jordan. The location has a Mediterranean climate with of mild rainy (300-350 mm) winters and dry hot summers. The soils used were shallow rocky silty clays. As measured for samples of the top 10 cm of the < 2 mm fraction of soil collected before the experiments started, soil pH [1:1 soil: water suspensions (Mc-Lean, 1982) was 8.1 and phosphorus extracted by 0.5 sodium bicarbonate at pH 8.5 (Olsen *et al.*, 1954) ranged from 2.3 to 6.0 mg kg^{-1}. In the date and rate of seeding experiments, phosphorus, as triple superphosphate (21% total P) was drilled 4 cm deep while sowing seed after cultivating the soil 6 cm deep. In both the date and seeding rate experiments and the phosphorus experiments, nitrogen fertilizer, as urea (46% total N) was applied uniformly by hand across all treatments, using 30 kg N ha^{-1} at sowing and 40 kg N ha^{-1} at the start of flowering. In all experiments, weeds were controlled by hand as needed.

Date and rate of seeding experiments. The experiments comprised a split plot design with rates of seeding as the main treatments (200, 250 and 300 plants m^{-2}) and seeding dates (1 Dec., 14 Dec. and 28 Dec.) as sub treatment. There were three replications. All plots consisted of four rows, 6 m long with spacing of 30 cm between rows and 60 cm between plots. A seeding depth of 6.0 cm was used.

Rate and method of phosphorus application. This experiments comprised a split plot design with rates of phosphorus as main the treatments (40, 60 and 80 kg P ha^{-1}) and placement methods (banding or broadcast) as sub treatment. The triple superphosphate (21% total P) was either placed (drilled) with the seed sown 6 cm deep after the soil was cultivated (banded P) or the triple superphosphate was spread over the soil surface (broadcast) and incorporated with a rotary hoe into the top 2 cm soil just before sowing seed 6 cm deep (broadcast). The plot size was the same as for the date and rate of seeding experiments. The seeding dates were 15 Dec in 2000 and 14 Dec in 2001. The seeding rate used was 250 plants m^{-2}.

Irrigation. To monitor soil moisture status permanent tensiometers were inserted horizontally at 150 mm depth into one lysimeter for each treatment. The tensiometers data were recorded at 11 and 16 h daily. The soil moisture content was calculated from the moisture release characteristics of the soil. To prevent moisture stress soils were maintained between 70 and 90% of field capacity (Rowarth, 1997) by the application of 18 mm of irrigation water when tensiometers indicated that the moisture stress had reached 70% of field capacity. Irrigation ceased five days before harvest in 2000 and four days before harvest in 2001.

Measurements. The following were measured for each experiment: seed yield (kg ha^{-1}), seed weight $plant^{-1}$ (g), number of spikes m^{-2}, plant height (cm) and spike length (cm).

Statistical analysis. Data for each trait were analyzed for a randomized complete block design (RCBD) with split plot arrangement according to Steel and Torrie (1980). Comparisons between means were made using least significant differences (LSD) at 0.05 probability level.

RESULTS AND DISCUSSION

No significant interaction between seasons was detected, probably due to irrigation being used. The main source of yield variation in the Mediterranean region is variation in rainfall. Therefore, the presented results are means across the two growing seasons.

Seeding rate. Plant density had a significant effect on all variables measured. Grain weight $plant^{-1}$ and spike length was negatively related to plant density.

As for grain weight per plant, it tended to decrease with increases in plant density (Table I). The lowest plant density of 200-plant m^{-2} produced the maximum grain weight $plant^{-1}$ (1.0 g) and vice versa. Reductions in barley grain weights have been associated with increasing plant density by Dofing and Knight (1992). Plants density (spikes m^{-2}) and grain yield were directly related to plant density. Grain yields increased as plant density increased, with highest yields being obtained at 300 plant m^{-2}. The yield increase observed with increase in plant density is a function of more spikes being produced as a result of more plants being establishment. The influence of plant density on grain yield was through the increased production of spikes per unit area (Table I). However, not through the increased production of fertile tillers per plant. This explains why maintain adequate plant populations is important for maximizing grain yield, given the low number of spikes produced, on average, per plant.

Seeding date. Seed yield of wall barley was influenced significantly by date of sowing (Table I). The maximum seed yield of 648.3 kg ha^{-1} was obtained by sowing wall barley on 1 December. After 1 December, reductions of seed yields of 9.0-18.6% were obtained for each delay of 14 days. The reduction in seed yield is attributed to the shorter growth period and time available for the later-sown crops to mature. The delay in sowing date greatly reduced spikes length and seed weight $plant^{-1}$. Our results are in general agreement with those of Turk and Tawaha (2001).

Phosphorus rate. Phosphorus levels significantly increased seed yields and yield components (Table II). Spencer and Chan (1991) observed that an optimal supply of P in the early stage of plant growth is a vital factor for the full development of seeds. An adequate supply of P increased the carboxylation efficiency and stimulate the ribulose 1,5-diphosphate carboxylase activity, resulting in an increased photosynthetic rate (Jacob & Lawlor, 1992). P levels significantly influenced seed yield. Increase in seed yield due to P application is well documented by many workers (Turk, 1998; Tawaha, 2000). Days to flowering decreased significantly with P application compared with control (data not shown), supporting previous results of Keatinge *et al.* (1985). This is attributed to increased rate of crop development from emergence to floral initiation and anthesis resulting from application of P in the P deficient soil.

Table I. Yield and yield components of wall barley as affected by date and rate of seeding

Treatments	Seed yield (kg ha^{-1})	Seed weight $plant^{-1}$ (g)	Spike length (cm)	Plant height (cm)	Spikes m^{-2}
Seeding rates (Plants m^{-2})					
200	506.7	1.0	6.0	30.0	403.3
250	579.3	0.7	4.5	35.3	496.7
300	680.0	0.5	3.3	41.0	613.3
LSD ($P \leq 0.05$)	62.0	0.2	0.9	3.9	88.0
Date of seeding					
1 Dec	648.3	0.9	6.3	40.3	560.0
14 Dec	590.0	0.7	4.5	35.3	503.3
28 Dec	527.7	0.5	3.0	30.7	450.0
LSD ($P \leq 0.05$)	44.0	0.2	1.1	3.7	43.0
Interaction	NS	NS	NS	NS	NS

Table II. Yield and yield components, of wall barley as affected by rates and methods phosphorus application

Treatments	Seed yield ($kg\ ha^{-1}$)	Seed weight $plant^{-1}$ (g)	Spike length (cm)	Plant height (cm)	Spikes m^{-2}
P rate ($kg\ ha^{-1}$)					
P1 (40)	553.0	0.7	3.3	33.0	376.5
P2 (60)	620.0	0.9	5.3	38.0	448.0
P3 (80)	700.0	1.6	6.7	43.0	582.0
LSD ($P \leq 0.05$)	43.0	0.2	1.3	3.7	54.0
P placement methods					
Band	660.0	1.2	5.1	40.3	504.0
Broadcast	589.0	0.8	5.1	35.0	433.3
LSD ($P \leq 0.05$)	54.0	0.2	NS	4.2	61.0
Interaction	NS	NS	NS	NS	NS

Phosphorus placement methods. Seed yield, spikes m^{-2}, spike length, and seed weight $plant^{-1}$ were significantly greater with band placement than with the broadcast methods of phosphorus application. A spike length was not affected by P placement methods. For soil used, seed yield of wall barley can be increased for soil with a moderate P status (10 mg Olsen soil test P kg^{-1} soil). The banded P treatments was more effective probably because the P was intercepted by plant roots growing into soil that was moist for longer during the growing season (Turk & Tawaha, 2001).

CONCLUSION

Wall barley yields were substantially increased by early sowing (1 Dec), high seeding rate (300 plant m^{-2}), and 80 kg P ha^{-1} banded with the seed after cultivation. Our results should apply to similar soils and environments in West Asia and North Africa.

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(Received 06 September 2003; Accepted 16 September 2003)