European Journal of Interdisciplinary Research and Development
Volume- 28 June - 2024
Website: www.ejird.journalspark.org ISSN (E): 2720-5746

# INFLUENCE OF SOWING DATES AND FERTILISER APPLICATION RATES ON PHOTOSYNTHETIC POTENTIAL OF WINTER BARLEY VARIETIES

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**Abstract**:
It was found that barley plant height decreased with delayed sowing date, resistance to lodging increased, increased with increasing fertiliser application rate, and resistance to lodging decreased. Photosynthetic potential (PP) of winter barley variety Mavlono makes from 1.155 to 2.207 million m2□сут/ha on irrigated lands depending on sowing dates and fertiliser application rates, of duvarak variety Bolgali - from 1.67 to 2.273 million m2□day/ha. When sown at 15.X of the growing seasons, FP changed from 1.464 million to 2.207 million m2□day/ha for the variety Mavlono and from 1.426 to 2.273 million m2□day/ha for the variety Bolgali, respectively. If sowing earlier or later than the optimum sowing date - 15.X. led to a decrease in FP of winter varieties Mavlono and Duvarak Bolgali, the increase in nitrogen fertilisers from 60 to 180/ha provided an increase in this indicator.

**Keywords**: barley, photosynthesis, Mavlono, Bolgali, fertilisation.

## Introduction

The aim of the study is to determine the optimal sowing dates and rates of mineral fertilisers application, providing the best quality grain yield with low production costs of intensive winter barley varieties grown on irrigated lands in the conditions of Kashkadarya province.

The subject of the study is growth, development, photosynthetic potential, photosynthetic productivity, yield, yield structure, nutrient elements content of barley grown in irrigated light grey soils of Kashkadarya province.

The main indicators of cenosis, as well as productivity, are calculated per 1 $m^2$ or 1 hectare. Leaf surface is also calculated in thousands of $m^2$/ha. In addition, leaf surface index is also used.

Photosynthetic potential (PP) depends on leaf surface area and the duration of the leaf activity period. Photosynthetic potential was determined experimentally between development phases. In our research in conditions of Kashkadarya province winter barley variety Mavlono depending on sowing dates and fertiliser application rates on irrigated lands produces FP from 1.155 to 2.207, variety Bolgali - from 1.67 to 2.273 million $m^2$·day/ha.

Photosynthesis can also occur in stems, axils, spikelet, green fruits and other organs, but their specific weight in total photosynthesis is very small. It is accepted to compare fields with each other and call the changing leaf surface of a field the ‘assimilation surface’ [1]-[3].

Leaf surface increases gradually in the field. Leaf surface first increases slowly (during germination), then rapidly (during tillering, tube emergence) and decreases with yellowing and dying of the lower leaves after the earing phase [1]-[3].

Leaf surface varies depending on the crop growing conditions and agronomic practices used. In dry years leaf surface can increase up to 5-20000 $m^2$/ha, and in case of sufficient moisture and nitrogen nutrition up to 70000 $m^2$/ha. When leaf index in the field is 4-5 (4-5 $m^2/m^2$), the photosynthesis system works in the optimal mode, and most of the active photosynthesis reaction is absorbed. The smaller the leaf surface, the less active photosynthesis reaction is taken up by the leaf surface. When the optimum leaf surface exceeds 50,000 $m^2$/ha, the lower leaves are shaded, their participation in photosynthesis decreases, and even the upper leaves 'feed' the lower leaves. [3].

The greatest number of leaf surfaces is observed in cereal grain crops in the phase of earing, flowering and milk ripeness of grain. In grain fodder crops, the main part of the forage mass is made up of leaves (monofodder), in which leaf surface can reach 60-80 thousand $m^2$/ha [2].

**Main part**

One of the main indicators of photosynthesis activity in a plant is leaf surface and dynamics of its formation. When the leaf surface is optimal during the vegetation period for a long period of time, it works actively and a high yield is formed. To this end, water supply, mineral nutrition, light radiation provide the highest productivity of photosynthesis, so that each plant in the growing season formed the optimal leaf surface per 1 hectare under certain soil and climatic conditions. Therefore, each agrotechnical method used to create the maximum leaf area has a positive effect on crop yield.

Barley leaf surface changes significantly under the influence of sowing dates, mineral nutrition and environmental factors. In our experiments, the largest leaf area per plant was observed at the optimal sowing date and the highest value of Fon+$N_{180}$. At the beginning of the vegetation period, the largest leaf area was observed in plants planted at early dates, and at later dates - in plants planted at optimal dates.

In our studies, leaf surface was determined at the stages of sprouting-bushing, tillering-emergence, tube emergence, tube emergence- spiking, spiking-milk ripeness, milk ripeness-wax ripeness. In the variety Mavlono, planted on the first October, in the period of sprouting and tillering leaf area per 1 ha varied from 17000 $m^2$/ha to 27000 $m^2$/ha depending on the rate of fertiliser application.

It was found that with the increase of mineral fertilisation the leaf surface per unit area increased, this indicator changed from 16 $m^2$/ha to 30 $m^2$/ha in the variety Mavlono. The surface of the highest leaves in the variety Mavlono, planted on the 15th October, increased from 19 $m^2$ to 32 $m^2$ depending on the rate of fertilisation, and in the variety Bolgali from 18000 $m^2$/ha to 34000 $m^2$/ha. A similar trend was observed in Bolgali variety (Table 1).

В период выхода в трубку-колошения наибольшая листовая поверхность у посевов, высаженных 15 октября, изменялась с 34 $м^2$/га до 58 $м^2$/га в варианте без удобрений и с 33 $м^2$/га до 62 $м^2$/га в варианте без удобрений у сорта Болгали.

Seed sowing on the 1 and 15 th November compared to 1 and 15 th October resulted in a decrease in leaf area. This pattern was observed in both varieties in the phases of tillering, tube emergence, tube emergence- spike-up, spike-up-milk ripeness, milk ripeness-wax ripeness.

During the vegetation period, the largest leaf surface area was in the tube emergence-peeling period at all sowing dates and variants of fertiliser application rates. The leaf surface area

increased from the period of sprouting to the period of tillering, emergence and sprouting. The regularity of leaf surface reduction was observed in the interphase period of earing-milk ripeness, milk ripeness-wax ripeness. This pattern was observed in both varieties.

During the tube spike-up period, the highest leaf area in the crops planted on the 15 th October changed from 34 $m^2$/ha to 58 $m^2$/ha in the variant without fertiliser and from 33 $m^2$/ha to 62 $m^2$/ha in the variant without fertiliser in the Bolgali variety.

**Table 1 Dynamics of leaf surface per 1 ha depending on sowing dates and fertiliser rates, by phases of plant development, thousand $m^2$/ha (2009-2012).**

| Sowing dates | Fertiliser application rates, kg/ha | Sprouting-cropping | Cultivation-tube emergence | Outlet to the tube-cutting | Spiking-milk ripeness | Milk ripeness-wax ripeness |
|---|---|---|---|---|---|---|
| Mavlono | | | | | | |
| 1.X | Without fertiliser | 17 | 25 | 31 | 21 | 18 |
| | $P_{90}K_{60}$ (fon) | 20 | 29 | 36 | 24 | 21 |
| | Fon+$N_{60}$ | 24 | 35 | 43 | 29 | 25 |
| | Fon+$N_{120}$ | 27 | 39 | 49 | 33 | 28 |
| | Fon+$N_{180}$ | 27 | 40 | 50 | 34 | 29 |
| 15.X | Without fertiliser | 19 | 28 | 34 | 23 | 20 |
| | $P_{90}K_{60}$ (fon) | 22 | 32 | 40 | 27 | 23 |
| | Fon+$N_{60}$ | 26 | 38 | 48 | 32 | 28 |
| | Fon+$N_{120}$ | 30 | 44 | 54 | 37 | 32 |
| | Fon+$N_{180}$ | 32 | 46 | 58 | 39 | 33 |
| 1.XI | Without fertiliser | 18 | 26 | 32 | 22 | 19 |
| | $P_{90}K_{60}$ (fon) | 21 | 31 | 38 | 26 | 22 |
| | Fon+$N_{60}$ | 24 | 36 | 45 | 30 | 26 |
| | Fon+$N_{120}$ | 27 | 40 | 50 | 34 | 29 |
| | Fon+$N_{180}$ | 28 | 41 | 51 | 35 | 30 |
| 15.XI | Without fertiliser | 15 | 22 | 27 | 19 | 16 |
| | $P_{90}K_{60}$ (fon) | 18 | 27 | 33 | 22 | 19 |
| | Fon+$N_{60}$ | 22 | 32 | 39 | 27 | 23 |
| | Fon+$N_{120}$ | 24 | 35 | 44 | 30 | 25 |
| | Fon+$N_{180}$ | 25 | 37 | 45 | 32 | 26 |
| Bolgali | | | | | | |
| 1.X | Without fertiliser | 16 | 24 | 30 | 20 | 17 |
| | $P_{90}K_{60}$ (fon) | 21 | 31 | 39 | 26 | 22 |
| | Fon+$N_{60}$ | 26 | 38 | 47 | 32 | 27 |
| | Fon+$N_{120}$ | 29 | 43 | 53 | 36 | 31 |
| | Fon+$N_{180}$ | 30 | 44 | 55 | 37 | 32 |
| 15.X | Without fertiliser | 18 | 26 | 33 | 22 | 19 |
| | $P_{90}K_{60}$ (fon) | 23 | 33 | 41 | 28 | 24 |
| | Fon+$N_{60}$ | 28 | 42 | 52 | 35 | 30 |
| | Fon+$N_{120}$ | 31 | 46 | 57 | 39 | 33 |
| | Fon+$N_{180}$ | 34 | 50 | 62 | 42 | 36 |
| 1.XI | Without fertiliser | 17 | 25 | 31 | 21 | 18 |
| | $P_{90}K_{60}$ (fon) | 19 | 28 | 35 | 24 | 20 |
| | Fon+$N_{60}$ | 23 | 33 | 41 | 28 | 24 |
| | Fon+$N_{120}$ | 26 | 38 | 48 | 32 | 28 |
| | Fon+$N_{180}$ | 27 | 40 | 50 | 34 | 29 |
| 15.XI | Without fertiliser | 15 | 22 | 27 | 19 | 16 |
| | $P_{90}K_{60}$ (fon) | 17 | 26 | 32 | 22 | 18 |
| | Fon+$N_{60}$ | 22 | 32 | 39 | 27 | 23 |
| | Fon+$N_{120}$ | 24 | 35 | 44 | 30 | 26 |
| | Fon+$N_{180}$ | 25 | 37 | 45 | 31 | 27 |

Thus, the maximum leaf surface per 1 ha in the conditions of Kashkadarya region formed winter barley varieties Mavlono and Bolgali at sowing on the 15th October, and the varieties Mavlono and Bolgali it is - 58 $m^2$/ha and 62 $m^2$/ha per 1 ha, respectively, at the variant Fon + $N_{180}$. By the stage of milk-wax ripeness actively working assimilative surface in both varieties sharply decreased.

Mineral fertilisers led to prolongation of leaf activity. In order to obtain high yields in the field, it is necessary to create sufficient photosynthetic potential (PP). Increasing the PP within one variety is based on the increase of leaf surface area and its maximum index.

The sum of the duration of the interphase period of leaf surface in the growing season of barley constitutes photosynthetic potential. In our studies, data on changes in photosynthetic potential of winter varieties Mavlono and Bolgali depending on sowing dates and fertiliser application rates are presented in Table 2.

In our experiments, the lowest photosynthetic potential was observed in the initial phases of development of barley varieties - during germination and sprouting.

Winter barley varieties grown in Uzbekistan have high potential yields, but this potential is not utilised due to unfavourable factors of crop cultivation, and leaf area is not optimal for the variety and the region. As a rule, leaf area increases slowly in the early stages of crop development, and optimal leaf area is active for a short period of time. Photosynthetic potential (PP) is an important indicator of photosynthetic activity of plants and is adjusted by crop size [2], [4]-[7].

A slow increase in leaf area is undesirable, especially in sparsely vegetated fields, because it leads to an inefficient use of the time required for an active photosynthetic reaction [3].

The increase in leaf area, occurring very quickly (with a large number of stems per 1 $m^2$), negatively affects the formation of economically valuable ear [1].

In our experiments, winter varieties Mavlono and Bolgali formed the highest FP between the phases of sprouting and tillering, and in the variety Mavlono this indicator ranged from 0.154 to 0.224, and in the variety Bolgali from 0.126 to 0.238. million $m^2$·day/ha. Sowing dates at the beginning of 1.X and at the end of 1.XI, 15.XI led to a decrease in FP. In the next phase of development, between tillering and tube emergence, the same pattern was observed in the variety Mavlono. However, compared with tillering in the previous period, an increase in FP by 2-3 times was observed in all variants, respectively (Table 2).

**Table 2 Effect of sowing dates and fertiliser application rates on photosynthetic potential of barley varieties, million m2/ha·day, (2010-2012).**

| Sowing dates | Fertiliser application rates, kg/ha | Sprouting-cropping | Cultivation-tube emergence | Outlet to the tube-cutting | Spiking-milk ripeness | Milk ripeness-wax ripeness | During the growing season |
|---|---|---|---|---|---|---|---|
| Mavlono | | | | | | | |
| 1.X | Without fertiliser | 0,111 | 0,275 | 0,434 | 0,263 | 0,072 | 1,155 |
| | $P_{90}K_{60}$ (fon) | 0,130 | 0,334 | 0,504 | 0,312 | 0,084 | 1,364 |
| | Fon+$N_{60}$ | 0,156 | 0,403 | 0,602 | 0,377 | 0,113 | 1,651 |
| | Fon+$N_{120}$ | 0,176 | 0,449 | 0,711 | 0,446 | 0,126 | 1,908 |
| | Fon+$N_{180}$ | 0,176 | 0,460 | 0,725 | 0,476 | 0,145 | 1,982 |
| 15.X | Without fertiliser | 0,133 | 0,252 | 0,459 | 0,299 | 0,080 | 1,223 |
| | $P_{90}K_{60}$ (fon) | 0,154 | 0,288 | 0,540 | 0,378 | 0,104 | 1,464 |
| | Fon+$N_{60}$ | 0,182 | 0,361 | 0,648 | 0,432 | 0,126 | 1,749 |
| | Fon+$N_{120}$ | 0,210 | 0,418 | 0,756 | 0,481 | 0,160 | 2,025 |
| | Fon+$N_{180}$ | 0,224 | 0,460 | 0,812 | 0,546 | 0,165 | 2,207 |
| 1.XI | Without fertiliser | 0,153 | 0,117 | 0,416 | 0,253 | 0,095 | 1,034 |
| | $P_{90}K_{60}$ (fon) | 0,179 | 0,155 | 0,494 | 0,312 | 0,099 | 1,239 |
| | Fon+$N_{60}$ | 0,204 | 0,198 | 0,585 | 0,375 | 0,104 | 1,466 |
| | Fon+$N_{120}$ | 0,230 | 0,240 | 0,675 | 0,408 | 0,116 | 1,669 |
| | Fon+$N_{180}$ | 0,238 | 0,267 | 0,663 | 0,473 | 0,135 | 1,776 |
| 15.XI | Without fertiliser | 0,180 | 0,011 | 0,324 | 0,209 | 0,064 | 0,788 |
| | $P_{90}K_{60}$ (fon) | 0,216 | 0,014 | 0,396 | 0,253 | 0,076 | 0,955 |
| | Fon+$N_{60}$ | 0,264 | 0,016 | 0,468 | 0,311 | 0,092 | 1,151 |
| | Fon+$N_{120}$ | 0,288 | 0,035 | 0,528 | 0,345 | 0,113 | 1,309 |
| | Fon+$N_{180}$ | 0,300 | 0,037 | 0,563 | 0,384 | 0,130 | 1,414 |
| Bolgali | | | | | | | |
| 1.X | Without fertiliser | 0,104 | 0,240 | 0,405 | 0,250 | 0,068 | 1,067 |
| | $P_{90}K_{60}$ (fon) | 0,137 | 0,310 | 0,527 | 0,338 | 0,088 | 1,400 |
| | Fon+$N_{60}$ | 0,169 | 0,380 | 0,635 | 0,432 | 0,108 | 1,724 |
| | Fon+$N_{120}$ | 0,189 | 0,409 | 0,742 | 0,486 | 0,124 | 1,950 |
| | Fon+$N_{180}$ | 0,195 | 0,396 | 0,770 | 0,500 | 0,160 | 2,021 |
| 15.X | Without fertiliser | 0,126 | 0,182 | 0,462 | 0,275 | 0,076 | 1,121 |
| | $P_{90}K_{60}$ (fon) | 0,161 | 0,231 | 0,574 | 0,364 | 0,096 | 1,426 |
| | Fon+$N_{60}$ | 0,196 | 0,294 | 0,728 | 0,455 | 0,120 | 1,793 |
| | Fon+$N_{120}$ | 0,217 | 0,322 | 0,827 | 0,527 | 0,149 | 2,042 |
| | Fon+$N_{180}$ | 0,238 | 0,350 | 0,899 | 0,588 | 0,198 | 2,273 |
| 1.XI | Without fertiliser | 0,145 | 0,113 | 0,403 | 0,252 | 0,072 | 0,985 |
| | $P_{90}K_{60}$ (fon) | 0,162 | 0,126 | 0,473 | 0,300 | 0,080 | 1,141 |
| | Fon+$N_{60}$ | 0,196 | 0,149 | 0,554 | 0,364 | 0,108 | 1,371 |
| | Fon+$N_{120}$ | 0,221 | 0,171 | 0,672 | 0,416 | 0,140 | 1,620 |
| | Fon+$N_{180}$ | 0,230 | 0,180 | 0,700 | 0,459 | 0,160 | 1,729 |
| 15.XI | Without fertiliser | 0,180 | 0,022 | 0,311 | 0,209 | 0,072 | 0,794 |
| | $P_{90}K_{60}$ (fon) | 0,204 | 0,026 | 0,368 | 0,242 | 0,072 | 0,912 |
| | Fon+$N_{60}$ | 0,264 | 0,032 | 0,449 | 0,297 | 0,092 | 1,134 |
| | Fon+$N_{120}$ | 0,288 | 0,035 | 0,528 | 0,330 | 0,117 | 1,298 |
| | Fon+$N_{180}$ | 0,300 | 0,037 | 0,563 | 0,341 | 0,135 | 1,376 |

**Conclusion**

It was found that barley plant height decreased with delayed sowing date, resistance to lodging increased, increased with increasing fertiliser application rate, and resistance to lodging decreased. Photosynthetic potential (PP) of winter barley variety Mavlono makes from 1.155 to 2.207 million $m^2$·day/ha on irrigated lands depending on sowing dates and fertiliser application rates, of variety Bolgali - from 1.67 to 2.273 million $m^2$·day /ha. When sown on the 15th October of the growing season, FP changed from 1.464 million to 2.207 million $m^2$·day/ha for the variety Mavlono and from 1.426 to 2.273 million $m^2$·day /ha for the variety Bolgali, respectively. If sowing earlier or later than the optimum sowing date – the 15th October led to a decrease in FP of winter varieties Mavlono and Bolgali, the increase in nitrogen fertilisers from 60 to 180/ha provided an increase in this indicator.

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