# Effect of Weak Electro-Magnetic treatments on Seedling Growth and Protein properties of Different Wheat ( *Triticum aestivum* L .) Cultivars

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## Keywords

Weak Electro-Magnetic Field,
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## Abstract

Seedling growth data were used during this study for the evaluation of nine wheat (*Triticum aestivum* L.) cultivars. Grains of different cultivars of wheat were exposed in batches to weak electric magnetic fields (3000 gauss or 0.3T of magnetic force) for 30 min. Twenty one days after planting the, seedling length and effect of magnetic treatments on protein patterns in the different wheat seedling cultivars, number of protein bands, molecular weights bands as well as percentage of protein band were determined and compared with the patterns of normal seedlings. The results showed that all magnetic field treatments caused an increased in the seedling length and all properties of protein patterns in different seedlings wheat cultivars Giza168, Tabouki, Kaseemi, Yamanei, Madini, Nagrani and Seds 12. The highest increase was observed when grain exposed to weak electric magnetic field strengths 0.3 T at 30 min and dip in magnetic water compared with control and cultivar Sakha93 showed decrease in seedling growth parameter and properties of seedling protein bands when exposed to all magnetic field treatments compared with controls, while cultivar Masr1 had no effected when treated compared with control.

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## Introduction

The Earth´s magnetic field with intensity of $5.10^{-6}$ is a natural factor that affects all living organisms. Artificial magnetic fields (MFs) are used for many practical be specific on application during everyday life in industry and medical treatment. However, the application of MFs in biology science is still a relatively unexplored field. In 1930, a study by Savostin (1930), quoted by Belyavskaya (2001 and 2004) reported that MFs affected the growth of wheat seedlings by increasing the rate of growth. Since then, scientists started to pay attention to the effects of MFs on the growth and development of many agricultural plants. Many authors reported that MFs affected the metabolism and mechanism of different plants growth based on the type of magnet, magnetic intensity, polarity orientation and length or duration of exposure to magnetic radiation. Chemical and physical mutagens were used widely for producing mutations and/or increasing genetic variability in target materials. It is well known that mutagens could directly induce physiological changes, point mutations and chromosomal aberrations. Magnetic field (MF) can also be used for the same purpose due to their biological effects (Mastude *et al*., 1993). There are a lot of biological effects include carcinogenesis that has been attributed to MF, but no clear data about the mutagenic effect of MF exist. Schreiber *et al*., 2001; Novikov *et al*., 2002). The evaluation of MF effects on the biological systems is difficult, since most of the biological structures are heterogeneous (Goodman *et al*., 1995).

Several researches tried to define the effect of weak electro-magnetic field on the growth rate of the wheat plant. The influence of a magnetic field (MF) on the early growth processes in wheat plant grains was studied and it was concluded that plant grains were attenuated when the ratio between the periods of exposure and non-exposure increases (Es,kov and Darkov, 2003). Hanafy *et al*., (2006) indicated that the electric magnetic field showed a high frequency of chromosomal abnormalities and the treated wheat flower buds showed a marked increase in the frequency of the nonviable pollen grains. They also reported that the changes in the growth characters were an increase in stem length with a spike in weight whilst the number of grains in the spike decreased. Their data further showed an increase in the total chlorophyll content as well as total carbohydrates in the grains. It was also indicated that the molecular structure and molecular weights of the extracted water soluble protein have changed with the amount of protein in the bands of exposed grains decreased. Hozayn and Abdul Qados (2010) reported that the growth parameters and yield components such as photosynthetic pigment, endogenous total indole and phenol as well as protein synthesis of wheat plants is concomitantly increased when irrigated with increasing exposure to magnetic water. Sema and Ayse (2011) calculated the total protein amount of a control and MF exposure groups of the regenerated mature embryo explants cultures of Flamura – 85 variety at 595 nm wavelength and using BSA as the standard. Total protein amount of 2.2 s (25.18%) and 19.8 s (34.41%) MF applied regenerated plant explants showed an increase by of 12.09 % and 13.51 % compared to the control, respectively. The aim of this investigation was to study the effect of low electro-magnetic field strength (0.3 T at 30 min ) treatment on the performance ( seedling length ) of nine wheat cultivar as well as the effect of magnetic field exposure and irrigation by magnetic water treatments (delete) on protein patterns in different wheat leaves cultivars , number of protein bands , molecular weights and percentage of protein band amount in all wheat cultivars studied .

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## Materials and Methods

### Plant material

Nine wheat cultivars (*Triticum aestivum* L.) including Giza168, Sakha 93, Masr1 and Seds 12 were obtained from local market, Field Crops Institute, Agriculture Research Centre, Giza, Egypt, and Tabouki, Kaseemi, Yamanei, Madini and Nagrani were obtained from local market, Jeddah, Saudi Arabia.

### Magnetic treatments

Grains without visible defect, insect damage and malformation were selected and divided into four groups in a complete randomized design. Each group consisted of three replicates (each replicate is one Petri dish containing 20 healthy grains). The groups were named as follows, group 1: exposure to magnetic field and dipping in magnetic water, group 2: exposure to magnetic field and dipping in tap water; group 3: no exposure to magnetic field and dipping in magnetic water, and group 4 : no exposure to magnetic field and dipping in tap water (control). Drought grains were exposed for 30 min to a constant pulsed magnetic field by placing them between the poles of an electromagnet (58 mm in diameter, located 30 mm apart) with the longitudinal (body) axis oriented along the magnetic lines of force at a magnetic field strength 0.3 T .

### Protein analyses

This experiment was performed to determine the impact of magnetic radiation on the nine wheat cultivars grown under optimum conditions. A complete randomized design with three replicates was used. Each replicate consisted of 20 grains that were sown in a plastic pot (19 cm height, 15 cm diameter) filled with a soil mixture (2 soil: 1 peat moss) and irrigation provided when required. The plastic pots were maintained under greenhouse conditions with natural light. Three weeks after planting a dry mass (50 mg) of each cultivar exposed to magnetic radiation and magnetic water were frozen with liquid nitrogen and grounded into a powder. The total soluble proteins were extracted in SDS reducing buffer composed of deionized water (38 ml) , 0.5 M Tris -HCl -pH 6.8 (10 ml ) , glycerol (8 ml) , 10 % (w/v) SDS (16 ml ) , 2-mercapto-ethanol (4ml) and 1% (w/v) bromophenol blue (4ml). Sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS-PAGE) was carried out with 10% acrylamide slab gels (Laemmli, 1970) and an electric current of 25 mA with a potential difference of 130 volts per gel during a period of 3hrs. After electrophoresis the protein bands were stained with Commassie Brilliant R250 colour reagent and detected by scanning the gels on a Gel Doc Bio-Rad System (Gel – Pro analyzer V3). Denso-grams were constructed and used for comparative analyses of electrophoretic profiles obtained from the various cultivars exposed to magnetic treatment.

## Results and Discussions

Seedling growth parameters of nine wheat ( *Triticum aestivum* L.) cultivars exposed to magnetic treatments were evaluated. The results illustrated in figure 1 showed that the seedling length of Giza168, Tabouki, Kaseemi, Yamanei, Madini, Nagrani and Seds12 was increased after magnetic field treatments compared to the control treatment. These results are in agreement with those reported by Ibrahim and Khafagi (2004) who concluded that seedlings from *Pergamum harmala* L. exposed to magnetic field radiation were significant higher compared to the control values. Hanafy *et al*. (2006) indicated that the electric magnetic field effect on the morphological characters were a stem length increased while Hozayn and Abdul Qados (2010) reported that the growth parameter and yield components of wheat

plants were concomitantly increased when wheat plants were irrigated with magnetic water .

Compared to control treatments the maximum seedling length parameter was obtained when magnetic grain treatment and magnetically treated water were jointly applied while a negative stimulation was experienced with Sakha93 cultivar as recorded by Tahir *et al*. 2010 and Abou El-Yazied *et al*. 2011.

The magnetic treatment however does not effect the seedling length of Masr1cultivar. Similar results were recorded by Kordas (2002) who concluded a stimulating effect on the root system and green tips and an inhibitory affect on the growth dynamics which resulted in a shortening of plants.

SDS-PAGE gel electrophoresis for the treated and un treated nine cultivars of wheat seedling cultivars through exposure to different of magnetic field and water treatments are analyzed **.**

The results tabulated in Tables 1 and 2 showed cultivar Giza 168 with a high number of protein bands (20 PBs) when exposed to a magnetic field and dipping in magnetic water . Their molecular weights ( MW) ranged between 85 to 10 KDa and a low number of protein bands (8 PBs) when not exposed to a magnetic field and dipping in tap water were observed with a molecular weight range between 78 to 22 KDa . On the contrary, distinctive bands with a high percentage of protein were observed in all samples exposed to magnetic radiation with the percentage contribution as follows: band numbers 1 and 2 in treated group 1 recorded 20.14 % and 18.17 % ,respectively , bands numbers 11 and 12 in treated group 2 recorded 19.43% and 16.73 % , respectively , bands numbers 11 and 14 in treated group3 recorded 17.21 % and 25.95% respectively , and finally band number 7 in treated group 4 recorded 16.09 % . These results hinted that it would be acceptable to assume that there is a possible correlation between the magnetic treatments and the protein band presence and / or absence. The protein band markers suggested for detection the effect of different magnetic treatments on cultivar Giza 168.

The data reported in Tables (1, 2, 3, 4 and 5) and illustrated in Figure 2 revealed that the wheat cultivars (Tabouki , Kaseemi , Yamanei , Madini , Nagrani and Seds12) experienced an increase in protein band numbers when exposed to a magnetic field and irrigated by magnetic water. Similar result was noticed by Sema and Ayse (2011) who calculated the total protein amount of the control and MF applied groups of the regenerated mature embryo explants cultures of Flamura – 85 variety. Total protein amount of 2.2 and 19.8 s MF applied regenerated plant explants showed increase by 12.09 % and 13.51 % compared to the control, respectively. While Sakha93 cultivar experienced a negative stimulation to magnetic field and magnetic water treatments and recorded a high number of protein bands of 18 PBs in control treatment, their molecular weights (MW) ranged between 78 to 10 KDa while a low number of 9 PBs was recorded when exposed to a magnetic field and dipping in magnetic water. The resulted MWPs ranged between 75 to 20 KDa and in contrast, we can distinguishable sole bands include high percentage of protein band amount in all magnetic treatments.

The magnetic treatments however does not effect on the number of protein bands for Masr1 when compared to those of the control treatment. These results indicate that the wheat seedling treated with magnetic field and water characterized the disappearance of certain bands and the appearance of new ones as compared to the control plant. The magnetic treatments had an effect on the percentage of protein bands in all treatments by magnetic treated , we can distinguishable and the sole bands include a high percentage

of protein band amount such as , band number 7 in treated group 1 which recorded 24.71 % , bands numbers 3 and 6 in treated group 2 recorded 32.66 % and 40.83 % , respectively , bands numbers 14 in treated group3 recorded 18.02 % and finally band number 5, 6 and 7 in treated group 4 recorded 16.08 % , 18.60 % and 20.50 % , respectively. Therefore, very small differences were observed in estimating the MF-dependence of the expression of a single gene or of the rates of total DNA replication, RNA transcription and protein translation. These results indicate that the wheat seedling treated with a magnetic field and water were characterized by the disappearance of certain bands and the appearance of new ones as compared to the control seedling. Similar result was noticed by Hozayn and Abdul qados (2010) who found that the magnetic water treatment of other wheat cultivars showed an increase in the number of protein bands to 16 bands and the formation of new protein bands in wheat plants treated with magnetic water that was accompanied with increasing growth promoters and total indole acetic acid in treated plants. Shabrangi and Majd (2009**)** reported that a magnetic field is known as an environmental factor which effects on (delete) gene expression, therefore, by augmentation of biological reactions like protein synthesis. Balouchi *et al*., (2007) confirmed that MF influences the structures of cell membrane, and increases their permeability and ion transport, which then affects some metabolic pathways. Moon and Chunge (2000) reported that magnetic field treatments influencing the biochemical process involving free radicals by stimulating the activity of proteins and enzymes. In addition, the changes in the protein electrophoretic profile have been attributed to the occurrence of either gene mutation or indication of cytological aberrations. Also, the increase or decrease in band´s intensity in the present study after exposure to electric field can be interpreted on the basis of the gene mutation at regulatory systems that control the concerned structural genes. On the other hand, changes in band´s intensity were due to gene duplication resulted from bridges and laggards that are observed at cytological analysis. Therefore, the bridges could lead to gene duplication at one pole and deletion at the other pole, while laggards may be distributed randomly to either poles producing monosomic (gene deletion) or trisomic (gene duplication) cells (Hanafy *et al*., (2005)). Breaks, bridges, laggards and micronuclei may also lead to a loss of some genetic material and the disappearance of some bands could be explained also on the basis of protein degradation, that is in agreement with Hanafy *et al*., (2006) who indicated that the molecular structure of the extracted WSP changed the amount of protein in the bands of exposed grains by decreasing their molecular weights. Haggran *et al*., (2009**)** reported that the total protein quantity was estimated in seedlings of maize and bean before and after exposure to MF for 15 and 30 min, and that the total proteins of maize and bean seedlings after treatments were lower than that in control for both time of exposure times. Finally, the decrease in total protein of bean was more after treatment for 30 min than 15 min. EL-Bakatoushi (2010) indicated that the genetic diversity of individuals of wheat plants grown under transmission lines increases, although seed germination and amount of total soluble protein does not change.

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**Figure 1. Effect of magnetic treatments on seedling growth of different wheat grain cultivars .**

(a) . Exposure to magnetic field + Dipping in magnetic water.
(b) . Exposure to magnetic field + Dipping in tap water.
(c) . No exposure to magnetic field + Dipping in magnetic water.
(d). No exposure to magnetic field + Dipping in tap water.

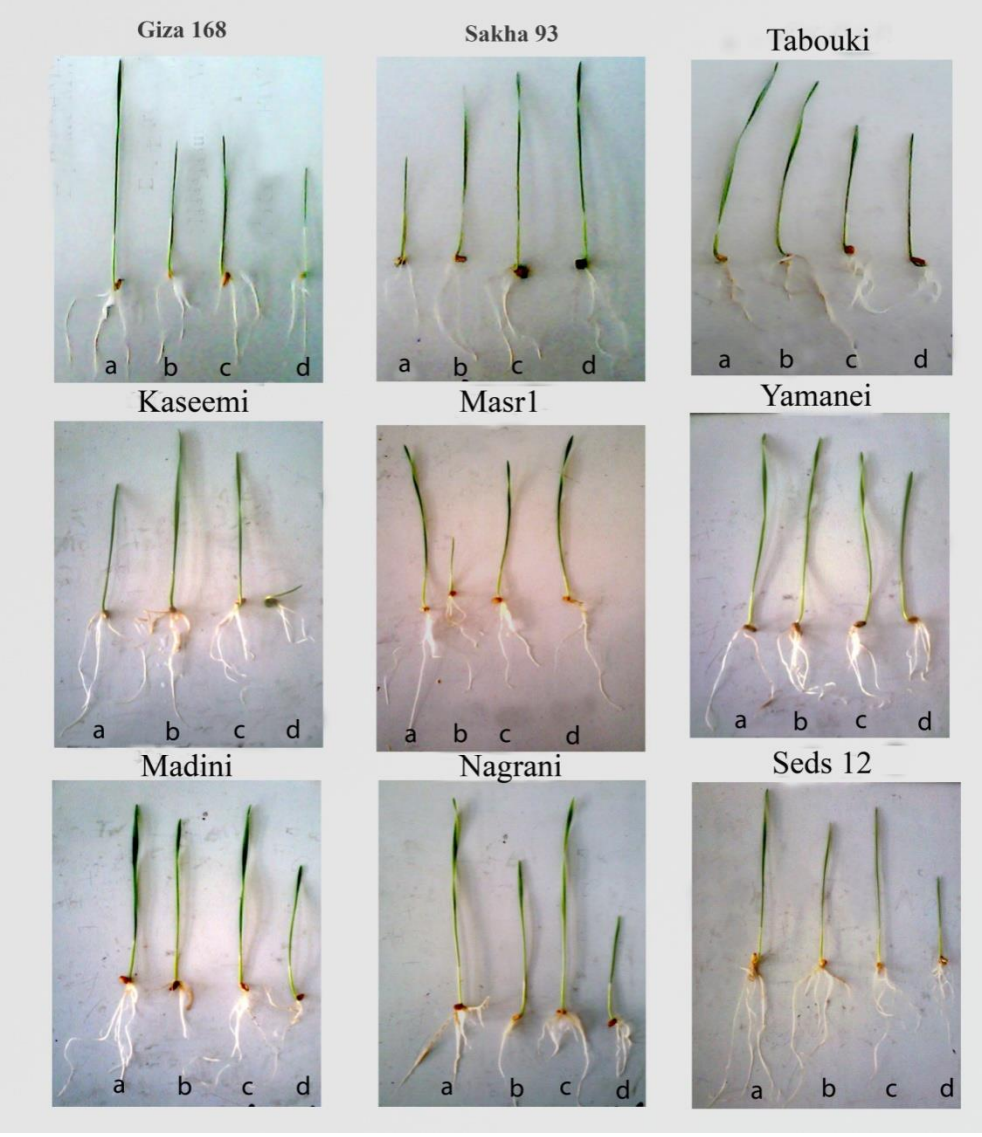

**Figure 2.** Electrophoretic profile of total soluble protein extracted from treated and un treated nine cultivars of wheat (Giza168, Sakha 93, Tabouki , Kaseemi , Masr1, Yamanei , Madini , Nagrani and Seds 12 ) under four groups treated . (a) . Exposure to magnetic field + Dipping in magnetic water. (b). Exposure to magnetic field + Dipping in tap water .(c) . No exposure to magnetic field + Dipping in magnetic water. (d). No exposure to magnetic field + Dipping in tap water.

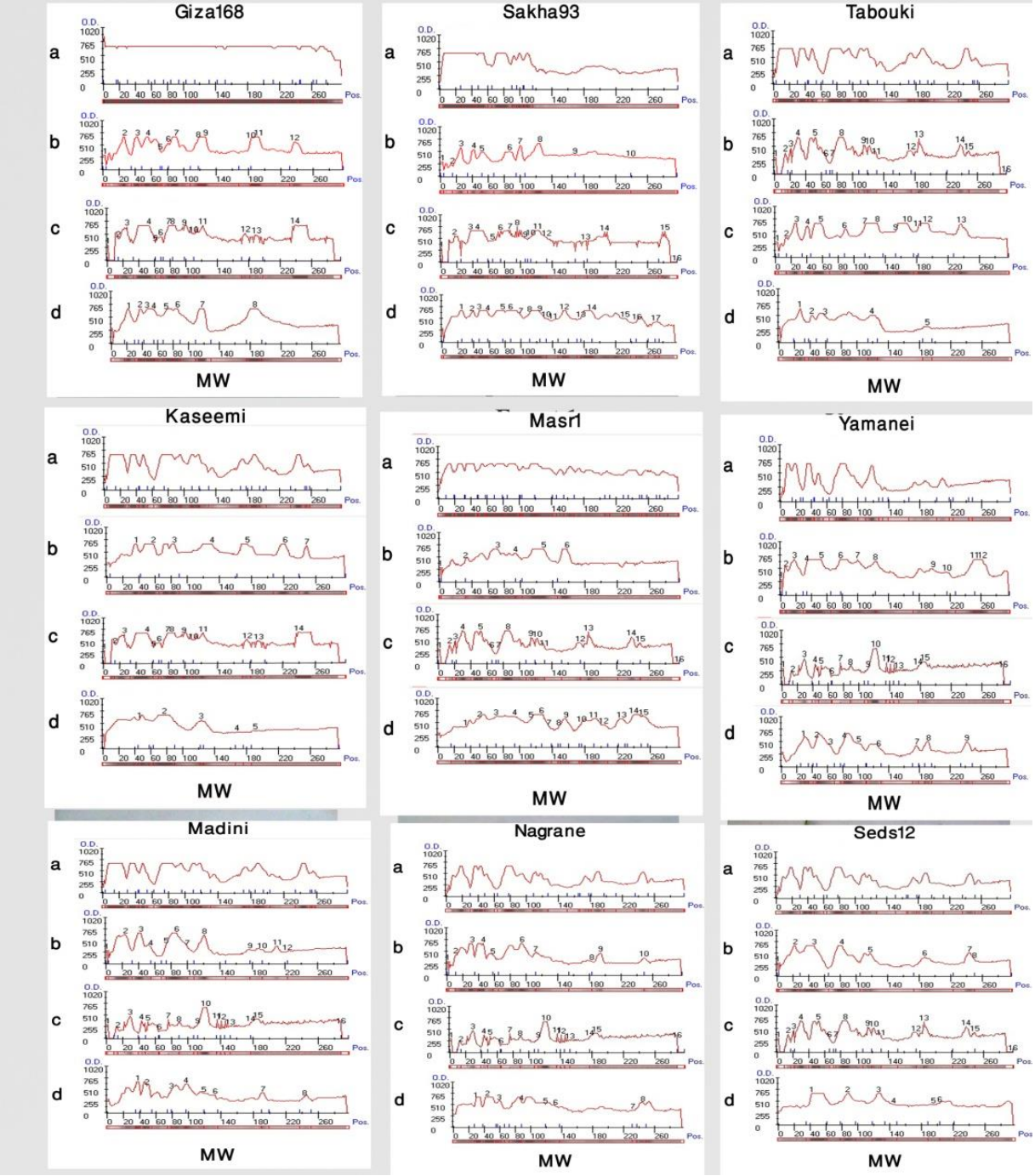

**Table 1.** Effect of magnetic treatments on protein bands in Giza168 and Sakha 93 cultivars of wheat seedling after 21 days from swelling

| M.W KDa | Properties of seedling protein bands in Giza168 cultivar | | | | | | | | Properties of seedling protein bands in Sakha 93 cultivar | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Group 1 | | Group 2 | | Group 3 | | Group 4 | | Group 1 | | Group 2 | | Group 3 | | Group 4 | |
| | B | % | B | % | B | % | B | % | B | % | B | % | B | % | B | % |
| 88 | - | - | + | 0.81 | - | - | - | - | - | - | + | 0.65 | - | - | - | - |
| 86 | - | - | - | - | + | 0.40 | - | - | - | - | - | - | + | 0.40 | - | - |
| 85 | + | 20.14 | - | - | - | - | - | - | - | - | + | 1.28 | - | - | - | - |
| 80 | + | 18.19 | - | - | + | 1.28 | - | - | - | - | - | - | + | 1.28 | - | - |
| 78 | - | - | + | 8.24 | - | - | + | 11.45 | - | - | + | 5.16 | - | - | + | 2.01 |
| 77 | + | 11.30 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 76 | - | - | - | - | + | 7.12 | - | - | - | - | - | - | + | 7.12 | - | - |
| 75 | - | - | - | - | - | - | - | - | + | 6.99 | - | - | - | - | - | - |
| 74 | + | 11.04 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 72 | - | - | + | 4.83 | - | - | + | 6.97 | - | - | + | 7.30 | - | - | + | 3.44 |
| 70 | + | 10.58 | - | - | - | - | | | + | 10.72 | - | - | - | - | - | - |
| 69 | - | - | - | - | - | - | + | 11.67 | - | - | - | - | - | - | - | - |
| 68 | - | - | - | - | - | - | | | + | 12.89 | + | 3.27 | - | - | + | 4.46 |
| 66 | - | | + | 9.75 | - | - | - | - | - | - | - | - | - | - | - | - |
| 65 | + | 10.08 | - | - | - | - | + | 4.82 | - | - | - | - | - | - | - | - |
| 64 | - | - | - | - | + | 12.83 | - | - | - | - | - | - | + | 12.83 | | |
| 63 | - | - | - | - | | - | - | - | + | 12.62 | | | | | + | 5.85 |
| 61 | - | - | - | - | + | 2.69 | - | - | - | - | - | - | + | 2.69 | - | - |
| 60 | - | - | + | 0.50 | - | - | - | - | - | - | - | - | - | - | - | - |
| 58 | - | - | - | - | + | 0.83 | + | 13.06 | - | - | - | - | + | 0.83 | - | - |
| 57 | + | 0.80 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 56 | - | - | + | 2.41 | - | - | - | - | - | - | - | - | - | - | - | - |
| 55 | - | - | - | - | - | - | - | - | - | - | + | 6.11 | | | + | 8.09 |
| 53 | - | - | - | - | + | 14.26 | - | - | + | 6.70 | - | - | + | 14.26 | - | - |
| 52 | - | - | + | 12.23 | - | - | - | - | - | - | - | - | - | - | - | - |
| 51 | - | - | - | - | + | 5.68 | + | 9.27 | - | - | - | - | + | 5.68 | + | 9.36 |
| 50 | + | 8.44 | - | - | - | - | - | - | + | 0.46 | + | 2.91 | - | - | - | - |
| 45 | - | - | - | - | + | 4.42 | - | - | + | 14.08 | - | - | + | 4.42 | + | 10.97 |
| 42 | - | - | + | 3.14 | - | - | - | - | - | - | - | - | | | + | 12.11 |
| 41 | + | 7.39 | - | - | + | 4.25 | - | - | + | 7.36 | - | - | + | 4.11 | - | - |
| 39 | - | - | + | 17.91 | - | - | + | 16.09 | - | - | + | 14.65 | - | - | - | - |
| 37 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | 13.75 |
| 36 | - | - | - | - | + | 17.21 | - | - | - | - | - | - | + | 12.21 | - | - |
| 34 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | 0.87 |
| 33 | + | 0.42 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 31 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | 11.99 |
| 30 | + | 6.01 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 28 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | 1.48 |
| 27 | + | 5.48 | - | - | - | - | - | - | - | - | + | 12.09 | - | - | - | - |
| 25 | - | - | + | 4.00 | - | - | - | - | - | - | - | - | - | - | - | - |
| 24 | + | 0.55 | | | - | - | - | - | - | - | - | - | - | - | + | 0.46 |
| 23 | - | - | + | 19.43 | + | 2.81 | | - | - | - | - | - | + | 2.81 | - | - |
| 22 | - | - | - | - | | | + | 12.19 | - | - | - | - | | | - | - |
| 21 | + | 0.46 | - | - | + | 4.52 | - | - | - | - | - | - | + | 4.52 | + | 2.17 |
| 20 | + | 0.70 | - | - | - | - | - | - | + | 12.17 | - | - | - | - | - | - |
| 18 | + | 0.71 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 16 | - | - | + | 16.73 | - | - | - | - | - | - | + | 11.57 | - | - | - | - |
| 15 | + | 0.70 | - | - | - | - | - | - | - | - | - | - | - | - | + | 7.24 |
| 13 | + | 0.67 | - | - | + | 25.95 | - | - | - | - | - | - | + | 13.95 | + | 1.33 |
| 11 | + | 0.43 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 10 | + | 0.37 | - | - | - | - | - | - | - | - | - | - | - | - | + | 0.41 |

**Table 2.** Effect of magnetic treatments on protein bands in Tabouki and Kaseemi cultivars of wheat seedling after 21 days from swelling

| M.W KDa | Properties of seedling protein bands in Tabouki cultivar | | | | | | | | Properties of seedling protein bands in Kaseemi cultivar | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Group 1 | | Group 2 | | Group 3 | | Group 4 | | Group 1 | | Group 2 | | Group 3 | | Group 4 | |
| | B | % | B | % | B | % | B | % | B | % | B | % | B | % | B | % |
| 88 | - | - | + | 0.63 | - | - | - | - | - | - | - | - | - | - | - | - |
| 86 | - | - | - | - | + | 0.35 | - | - | - | - | - | - | + | 0.34 | - | - |
| 84 | - | - | + | 1.31 | + | 0.25 | - | - | - | - | - | - | + | 0.28 | - | - |
| 79 | - | - | - | - | - | - | - | - | + | 2.24 | - | - | - | - | - | - |
| 78 | + | 40.76 | + | 6.44 | - | - | - | - | - | - | - | - | - | - | - | - |
| 77 | - | - | - | - | + | 4.75 | + | 25.30 | + | 0.35 | - | - | + | 5.32 | - | - |
| 76 | + | 8.15 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 75 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 74 | - | - | - | - | - | - | - | - | + | 0.88 | + | 11.35 | - | - | - | - |
| 73 | - | - | + | 20.88 | + | 3.51 | - | - | - | - | - | - | + | 0.15 | - | - |
| 70 | + | 4.35 | | | + | 8.74 | + | 16.10 | + | 0.94 | - | - | - | - | - | - |
| 69 | - | - | - | - | - | - | - | - | - | - | - | - | + | 9.41 | + | 9.46 |
| 68 | - | - | - | - | - | - | - | - | + | 1.18 | - | - | - | - | - | - |
| 66 | + | 4.09 | + | 7.06 | + | 2.65 | - | - | - | - | + | 9.34 | - | - | - | - |
| 65 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 64 | - | - | - | - | - | - | - | - | + | 1.15 | - | - | - | - | - | - |
| 63 | - | - | - | - | - | - | + | 15.51 | - | - | - | - | - | - | - | - |
| 62 | - | - | - | - | + | 1.91 | - | - | - | - | - | - | + | 1.40 | - | - |
| 60 | - | - | - | - | | | | | | | - | - | | | - | - |
| 58 | - | - | - | - | + | 1.16 | - | - | + | 2.02 | - | - | + | 1.09 | - | - |
| 57 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 56 | + | 2.32 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 55 | - | - | - | - | - | - | - | - | - | - | + | 9.94 | - | - | + | 11.70 |
| 53 | | | + | 4.19 | + | 4.52 | - | - | + | 2.04 | - | - | - | - | - | - |
| 52 | + | 3.74 | - | - | - | - | - | - | - | - | - | - | + | 14.50 | - | - |
| 51 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 50 | - | - | - | - | - | - | - | - | + | 1.14 | - | - | - | - | - | - |
| 47 | + | 12.19 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 44 | - | - | - | - | + | 24.18 | - | - | + | 2.20 | - | - | + | 3.24 | - | - |
| 43 | | | + | 10.63 | | | - | - | - | - | - | - | - | - | - | - |
| 39 | + | 10.61 | | | + | 8.44 | + | 11.03 | - | - | - | - | - | - | - | - |
| 38 | - | - | + | 18.43 | - | - | - | - | + | 18.38 | - | - | - | - | - | - |
| 37 | | - | - | - | - | - | - | - | - | - | + | 26.40 | + | 15.35 | + | 13.66 |
| 34 | + | 2.06 | - | - | - | - | - | - | - | - | - | - | + | 10.84 | - | - |
| 33 | - | - | - | - | - | - | - | - | + | 2.11 | - | - | - | - | - | - |
| 31 | - | - | - | - | - | - | - | - | - | - | - | - | + | 9.27 | - | - |
| 30 | - | - | + | 4.26 | - | - | - | - | + | 0.76 | - | - | - | - | - | - |
| 27 | - | - | + | 11.89 | - | - | - | - | + | 15.90 | - | - | - | - | - | - |
| 26 | - | - | - | - | - | - | - | - | - | - | + | 16.11 | - | - | - | - |
| 25 | + | 5.08 | + | 1.64 | - | - | - | - | + | 13.70 | - | - | - | - | + | 3.03 |
| 24 | - | - | | | + | 5.72 | | | + | 12.62 | - | - | - | - | - | - |
| 23 | - | - | + | 14.80 | - | - | - | - | - | - | - | - | + | 6.82 | - | - |
| 22 | + | 16.32 | - | - | | | | | + | 11.55 | - | - | - | - | - | - |
| 21 | | | - | - | + | 12.01 | + | 12.07 | - | - | - | - | + | 2.03 | + | 4.54 |
| 20 | + | 2.78 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 18 | - | - | - | - | - | - | - | - | | | + | 10.96 | - | - | - | - |
| 16 | - | - | + | 15.83 | - | - | - | - | + | 60.93 | | | - | - | - | - |
| 15 | - | - | - | - | - | - | - | - | - | - | + | 15.89 | - | - | - | - |
| 14 | + | 15.73 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 13 | + | 7.81 | - | - | + | 21.83 | - | - | + | 3.95 | - | - | - | - | - | - |
| 12 | - | - | - | - | | | - | - | - | - | - | - | + | 26.78 | | |

**Table 3**. Effect of magnetic treatments on protein bands in Masr1 and Yammanei cultivars of wheat seedling after 21 days from swelling

| M.W KDa | Properties of seedling protein bands in Masr1 cultivar | | | | | | | | Properties of seedling protein bands in Yammanei cultivar | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Group 1 | | Group 2 | | Group 3 | | Group 4 | | Group 1 | | Group 2 | | Group 3 | | Group 4 | |
| | B | % | B | % | B | % | B | % | B | % | B | % | B | % | B | % |
| 89 | - | - | + | 0.40 | - | - | - | - | - | - | + | 0.31 | - | - | - | - |
| 87 | - | - | - | - | - | - | - | - | - | - | + | 0.87 | - | - | - | - |
| 85 | - | - | - | - | + | 0.66 | - | - | - | - | - | - | - | - | - | - |
| 84 | + | 12.08 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 82 | - | - | - | - | - | - | - | - | - | - | + | 7.04 | - | - | - | - |
| 81 | - | - | - | - | - | - | - | - | + | 2.22 | - | - | - | - | - | - |
| 80 | - | - | - | - | + | 1.34 | - | - | | | - | - | + | 7.92 | - | - |
| 77 | - | - | - | - | + | 1.22 | - | - | + | 9.71 | - | - | - | - | - | - |
| 76 | + | 6.68 | + | 6.74 | - | - | - | - | - | - | + | 1.14 | - | - | + | 8.91 |
| 74 | - | - | - | - | + | 6.30 | + | 2.17 | - | - | - | - | - | - | - | - |
| 73 | - | - | - | - | - | - | - | - | - | - | - | - | + | 15.29 | - | - |
| 72 | - | - | - | - | - | - | - | - | + | 0.54 | - | - | - | - | - | - |
| 71 | + | 3.76 | - | - | - | - | - | - | | | - | - | - | - | - | - |
| 70 | - | - | - | - | - | - | - | - | + | 5.59 | - | - | - | - | - | - |
| 69 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | 3.44 |
| 68 | - | - | - | - | - | - | - | - | - | - | + | 11.05 | + | 6.82 | | |
| 67 | + | 1.69 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 66 | - | - | - | - | | | + | 4.79 | + | 4.25 | - | - | - | - | - | - |
| 64 | - | - | - | - | + | 10.11 | - | - | - | - | - | - | - | - | - | - |
| 61 | - | - | - | - | | | - | - | - | - | - | - | + | 5.81 | + | 22.73 |
| 60 | - | - | + | 32.66 | | | - | - | - | - | - | - | - | - | - | - |
| 58 | - | - | - | - | + | 0.86 | + | 8.44 | | | | | - | - | - | - |
| 57 | - | - | - | - | | | | | + | 1.38 | + | 3.59 | - | - | - | - |
| 55 | + | 4.16 | - | - | + | 0.45 | - | - | - | - | - | - | - | - | - | - |
| 53 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | 3.54 |
| 52 | - | - | - | - | - | - | - | - | + | 14.39 | - | - | - | - | - | - |
| 51 | - | - | + | 2.85 | - | - | - | - | - | - | - | - | - | - | - | - |
| 50 | - | - | - | - | + | 12.67 | - | - | - | - | - | - | - | - | - | - |
| 48 | - | - | - | - | - | - | + | 12.78 | + | 3.00 | + | 28.28 | - | - | - | - |
| 45 | + | 11.31 | - | - | - | - | | | | | | | - | - | + | 12.21 |
| 40 | - | - | - | - | - | - | + | 16.08 | + | 10.25 | + | 10.57 | - | - | - | - |
| 39 | + | 24.71 | - | - | + | 3.30 | - | - | - | - | - | - | - | - | - | - |
| 38 | - | - | + | 16.52 | - | - | - | - | - | - | - | - | + | 62.64 | - | - |
| 36 | - | - | - | - | + | 7.86 | + | 18.60 | - | - | - | - | | | + | 12.98 |
| 33 | - | - | - | - | + | 4.19 | + | 20.50 | - | - | - | - | + | 1.51 | - | - |
| 30 | + | 1.17 | - | - | - | - | | | - | - | - | - | - | - | - | - |
| 29 | | | + | 40.83 | - | - | + | 0.37 | - | - | - | - | - | - | - | - |
| 28 | + | 17.87 | - | - | - | - | | | - | - | - | - | - | - | - | - |
| 27 | + | 17.87 | - | - | - | - | + | 1.61 | - | - | - | - | - | - | - | - |
| 26 | + | 6.51 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 25 | - | - | - | - | - | - | - | - | + | 4.93 | - | - | - | - | - | - |
| 24 | - | - | - | - | - | - | + | 0.40 | - | - | - | - | - | - | - | - |
| 23 | - | - | - | - | + | 5.14 | - | - | - | - | - | - | - | - | + | 4.80 |
| 22 | - | - | - | - | | | - | - | - | - | + | 12.32 | - | - | | |
| 21 | - | - | - | - | + | 17.42 | + | 2.87 | - | - | | | - | - | + | 6.58 |
| 19 | + | 0.88 | - | - | - | - | + | 5.44 | + | 35.12 | + | 2.14 | - | - | - | - |
| 17 | + | 2.26 | - | - | - | - | + | 1.37 | - | - | | | - | - | - | - |
| 14 | + | 5.45 | - | - | - | - | + | 3.09 | - | - | + | 5.77 | - | - | + | 9.80 |
| 13 | - | - | - | - | + | 18.02 | - | - | - | - | + | 16.91 | - | - | - | - |
| 12 | - | - | - | - | + | 10.46 | + | 1.49 | + | 8.63 | - | - | - | - | - | - |
| 9 | + | 1.46 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

**Table 4.** Effect of magnetic treatments on protein bands in Madini and Nagrani cultivars of wheat seedling after 21 days from swelling

| M.W KDa | Properties of seedling protein bands in Madini cultivar | | | | | | | | Properties of seedling protein bands in Nagrani cultivar | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Group 1 | | Group 2 | | Group 3 | | Group 4 | | Group 1 | | Group 2 | | Group 3 | | Group 4 | |
| | B | % | B | % | B | % | B | % | B | % | B | % | B | % | B | % |
| 89 | - | - | + | 0.40 | - | - | - | - | - | - | + | 0.39 | - | - | - | - |
| 87 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 85 | - | - | - | - | + | 0.88 | - | - | - | - | + | 1.33 | + | 0.66 | - | - |
| 84 | - | - | - | - | - | - | - | - | + | 0.68 | - | - | - | - | - | - |
| 82 | - | - | - | - | - | - | - | - | - | - | - | - | + | 4.86 | - | - |
| 81 | + | 1.65 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 80 | - | - | + | 8.90 | + | 0.73 | - | - | + | 2.29 | - | - | - | - | - | - |
| 77 | + | 8.43 | - | - | - | - | - | - | + | 2.13 | - | - | - | - | - | - |
| 76 | - | - | - | - | - | - | - | - | - | - | + | 9.99 | - | - | + | 6.37 |
| 74 | - | - | - | - | + | 6.90 | - | - | + | 8.05 | - | - | - | - | | - |
| 73 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 72 | - | - | + | 9.26 | - | - | + | 4.49 | - | - | - | - | - | - | - | - |
| 71 | - | - | - | - | - | - | - | - | - | - | + | 9.71 | - | - | - | - |
| 70 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 69 | - | - | - | - | - | - | - | - | + | 8.16 | - | - | + | 3.84 | + | 10.25 |
| 68 | + | 10.45 | - | - | + | 2.17 | - | - | - | - | - | - | - | - | - | - |
| 67 | - | - | + | 1.94 | - | - | + | 9.01 | - | - | - | - | - | - | - | - |
| 66 | - | - | - | - | - | - | - | - | | | + | 1.72 | - | - | - | - |
| 64 | - | - | - | - | + | 4.13 | - | - | + | 1.98 | | | | | + | 4.66 |
| 61 | - | - | - | - | - | - | - | - | - | - | - | - | + | 5.44 | | |
| 60 | - | - | - | - | + | 0.13 | - | - | - | - | - | - | - | - | - | - |
| 58 | - | - | + | 0.99 | - | - | - | - | - | - | - | - | - | - | - | - |
| 57 | - | - | | | - | - | - | - | - | - | - | - | - | - | - | - |
| 55 | - | - | + | 12.29 | - | - | - | - | + | 6.69 | - | - | - | - | - | - |
| 53 | + | 13.32 | - | - | + | 10.23 | + | 2.34 | - | - | - | - | - | - | - | - |
| 52 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 51 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | 8.83 |
| 50 | - | - | - | - | + | 4.64 | | | | | + | 25.20 | + | 9.33 | - | - |
| 48 | - | - | + | 1.64 | - | - | + | 14.04 | + | 15.91 | - | - | - | - | - | - |
| 45 | - | - | - | - | - | - | - | - | - | - | + | 9.43 | + | 1.76 | - | - |
| 40 | + | 11.44 | + | 8.59 | + | 1.18 | | | + | 8.69 | - | - | + | 6.13 | - | - |
| 39 | - | - | - | - | - | - | + | 10.52 | + | 6.20 | - | - | - | - | + | 12.51 |
| 38 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 36 | - | - | - | - | + | 10.74 | - | - | + | 4.20 | - | - | + | 17.96 | - | - |
| 33 | - | - | - | - | + | 1.27 | + | 11.26 | - | - | - | - | | | + | 14.26 |
| 30 | - | - | - | - | + | 1.22 | - | - | - | - | - | - | - | - | - | - |
| 29 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 28 | + | 0.28 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 27 | - | - | - | - | + | 1.77 | - | - | - | - | - | - | + | 6.99 | - | - |
| 26 | - | - | + | 4.49 | - | - | - | - | - | - | - | - | - | - | - | - |
| 25 | + | 2.31 | - | - | - | - | - | - | + | 3.00 | + | 5.14 | - | - | - | - |
| 24 | + | 2.74 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 23 | | | + | 7.55 | + | 8.18 | - | - | - | - | + | 27.28 | - | - | - | - |
| 22 | + | 16.17 | - | - | - | - | - | - | + | 13.39 | - | - | + | 10.00 | - | - |
| 21 | | | + | 28.69 | + | 45.83 | + | 3.95 | - | - | - | - | - | - | - | - |
| 19 | + | 4.24 | + | 15.27 | - | - | - | - | - | - | - | - | + | 0.84 | - | - |
| 17 | + | 1.90 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 14 | + | 17.42 | - | - | - | - | + | 5.38 | + | 10.91 | + | 9.81 | | | + | 2.22 |
| 13 | + | 9.65 | - | - | - | - | - | - | + | 7.73 | | | + | 32.20 | + | 5.90 |
| 12 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| 9 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

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**Table 5.** Effect of magnetic treatments on protein bands in Seds 12 cultivar of wheat seedling after 21 days from swelling

| M.W KDa | Properties of seedling protein bands in Seds 12 cultivar | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Group 1 | | Group 2 | | Group 3 | | Group 4 | |
| | B | % | B | % | B | % | B | % |
| 89 | - | - | + | 0.47 | - | - | - | - |
| 87 | - | - | - | - | - | - | - | - |
| 85 | - | - | - | - | + | 0.68 | - | - |
| 84 | + | 0.40 | - | - | - | - | - | - |
| 82 | | | - | - | + | 0.61 | - | - |
| 81 | + | 2.27 | - | - | - | - | - | - |
| 80 | | | + | 9.55 | + | 1.52 | - | - |
| 77 | + | 7.11 | - | - | - | - | - | - |
| 76 | | | - | - | - | - | + | 6.37 |
| 74 | + | 1.90 | - | - | - | - | - | - |
| 73 | - | - | - | - | + | 7.78 | - | - |
| 72 | - | - | - | - | - | - | - | - |
| 71 | - | - | - | - | - | - | - | - |
| 70 | - | - | + | 15.00 | - | - | - | - |
| 69 | - | - | - | - | - | - | + | 10.25 |
| 68 | + | 15.76 | - | - | - | - | - | - |
| 67 | - | - | - | - | - | - | - | - |
| 66 | - | - | - | - | + | 9.81 | - | - |
| 63 | - | - | - | - | - | - | + | 4.66 |
| 61 | - | - | - | - | + | 2.77 | - | - |
| 60 | - | - | - | - | - | - | - | - |
| 58 | - | - | - | - | - | - | - | - |
| 57 | - | - | - | - | + | 2.64 | - | - |
| 56 | - | - | + | 14.58 | - | - | - | - |
| 53 | + | 14.45 | - | - | - | - | - | - |
| 52 | - | - | - | - | - | - | - | - |
| 51 | - | - | - | - | | | + | 8.83 |
| 50 | - | - | - | - | + | 13.98 | - | - |
| 48 | + | 2.64 | - | - | - | - | - | - |
| 43 | + | 11.29 | - | - | + | 2.09 | - | - |
| 42 | - | - | + | 16.15 | - | - | - | - |
| 39 | - | - | - | - | - | - | + | 14.51 |
| 38 | - | - | - | - | + | 11.30 | - | - |
| 36 | - | - | - | - | - | - | - | - |
| 35 | - | - | - | - | + | 6.19 | + | 13.26 |
| 32 | - | - | - | - | + | 3.69 | - | - |
| 29 | - | - | - | - | - | - | - | - |
| 28 | - | - | - | - | - | - | - | - |
| 27 | - | - | - | - | - | - | - | - |
| 26 | - | - | - | - | - | - | - | - |
| 25 | - | - | - | - | - | - | - | - |
| 24 | + | 18.49 | + | 12.41 | + | 4.28 | - | - |
| 23 | - | - | - | - | - | - | - | - |
| 22 | + | 1.31 | - | - | | | - | - |
| 21 | - | - | - | - | + | 15.42 | - | - |
| 19 | - | - | - | - | - | - | - | - |
| 17 | - | - | - | - | - | - | - | - |
| 16 | + | 18.58 | - | - | - | - | - | - |
| 15 | + | 12.65 | + | 19.74 | - | - | + | 2.22 |
| 13 | - | - | + | 12.09 | + | 20.22 | + | 5.90 |
| 12 | - | - | - | - | + | 19.21 | - | - |