CHAPTER 19

Tall Wheatgrass (*Thinopyrum ponticum* (Podp.) Barkworth & D.R Dewey

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INTRODUCTION

There is no definitive historical record of when the agriculture of forage crops began on Earth. Because the cultivation of forage crops has been carried out since the unwritten periods of history. It probably started when people learned to feed animals in prehistoric times. People who used to benefit from naturally grown plants, later, especially after they settled are thought to be interested in this culture (Ahlgren, 1956). Forage crops cultivation, which has a very important place in agricultural production is the insurance of plant and animal production and also it is the most basic way of producing sustainable and safe roughage. Forage crops are defined as plants that contain the nutrients that livestock have to take into their bodies so that they can live and produce the products expected from them, and do not adversely affect animal health and animal products when fed to animals in a certain amount, both cultured and grown in nature. Forage crops, the cornerstone of agriculture, whose main principle is animal feeding have a great importance in terms of containing the necessary nutrients for the stomach microflora of animals, being rich in minerals and vitamins, increasing the reproductive performance of animals, providing high quality animal products, improving the physical and chemical structures of agricultural soils, preventing erosion and creating turf establisment. The sources of forage crops used in the supply of quality roughage are grasses, legumes and forage crops of other family. In addition to legume forage crops in cultivation of forage crops, there are many alternative grases forage crops that considered green grass, dry

grass and silage, usable in green space facility and in soil protection, be able to take place in crop rotation systems, can be grown lean or mixed, has the potential to be roughage. The Poaceae family, which is the subclass of monocotyledoneaus, contains 650-785 genera and 10.000 species (Watson and Dallwitz, 1992). Grasses are the most used plant family of people in the world for nutrition and different purposes. All cereals and 75% of the cultivated forage crops are grasses. Grasses are the most important plants of rangeland in the cool season zone of the world. Grasses's cultivation on farmland as a forage crop is quite old. Nowadays, nearly 100 species of wheatgrass feed plants, which are used in agricultural area, meadow pastures, parks and gardens are cultivated. Grasses are of great importance in terms of animal nutrition, both as forage crops species grown in agricultural lands and as natural species grown in meadows and pastures. As a rangeland plant grasses are more resistant to grazing than legumes. Grasses are highly adaptable. They form the dominant plants of natural vegetation in unfavorable climate (cold, hot and arid) and soil (inefficient and deteriorated) conditions. They are resistant to low yielding, acidic and saline soil conditions, waterlogging and poor drainage. In places where the Mediterranean climate is dominant, the dominant plants of the winter period are the cool season grasses and the hot season grasses of the summer period.

About 150 of the grasses, which make up 75% of the cultivated forage crops, are wheatgrass species. About 11 of the 150 species mentioned have gained importance in terms of agriculture (Serin and Tan, 2009).

Wheatgrass, which is one of the grasses, have many species used as forage crops in the warm and cool climates of the world. The importance of these species is increasing day by day. Wheatgrass species are very resistant to cold and drought. There are species that can grow on alkaline, saline, wet and deconstructed soils where other plants cannot grow. Wheatgrasses, which form rhizomes and have a strong root system, by forming a good lawn cover, hold the soil tightly and prevent erosion. They are used for the renewal of destroyed meadow rangeland. Seed production of wheatgrass species is high. Sowing them with drill is easy. They produce delicious and high nutritional feed. Since all the vegetative parts of the rhizome and ball-forming wheatgrass species are not preferred by the animals, they have the opportunity to shoot again from the remaining green parts. Therefore, they are resistant to grazing. High hay yields and nutritive value of wheatgrass, resistance to grazing and wearing, germination of seeds even at low temperature and with their rapid development in early spring It has been reported that they are important plant species for rangeland under continental climate zone (Elçi and Açıkgöz, 1993; Elçi, 2005; Altın et al., 2009). Apart from animal nutrition, wheatgrass species are also widely used in the greening of parks, gardens and sports areas.

Table 1. Some important wheatgrass species (Hanson and Karnahan 1956; Açıkgöz, 2021)

Latin name	**Turkish name**
A. cristatum (L.) Gaertn.	Otlak ayrığı
A. dasytachyum (Hook) Scribn	Kum ayrığı
A. desertorum (Fish, Link) Schult.	Kır ayrığı
A. elongatum (Houst) Beauv.(Thinopyrum ponticum (Podp.) Barkworth& D.R Dewey) *A. fragile (Roth) Nevski.*	Yüksek otlak ayrığı
A. inerme (Scribn Smith) Rydb.	Kılçıksız ayrık
A. intermedium (Haust) Beauv. (Thinopyrum intermedium (Host) Dewey)	Mavi ayrık
A. repens (L.) Beauv. (Elytrigia repens L. Newski=Elymus repens)	Tarla ayrığı
A. riparium Scribn ve Smith	Dere ayrığı
A. sibiricum (Wild) Beauv.	Sibirya ayrığı
A. smithii Rydb.	Batı ayrığı
A. spicatum (Pursh) Sribn ve Smith.	Yeşil ayrık
A. trachycaulum (Link) Malte.	Silindir ayrık
A. trichophorum (Link) Richt.	Tüylü ayrık
Elymus trachycualus	Narin ayrık

In taxonomic studies on this genus, the naming of wheatgrass species has been renewed and some species previously named *Agropyron* have been included in different genera. This new classification is important for the recognition of plants.

Tall Wheatgrass

One of them, the tall wheatgrass, was classified as *Agropyron elongatum* (Host) Beauv. in previous years and was included as *Thinopyrum ponticum* (Podp.) Barkworth& D.R Dewey in the new taxonomy. The chromosome number of the tall wheatgrass, which has a similar genome with the intermediate wheatgrass, is 2n=70 (Açıkgöz, 2021).

Table 2. Scientific classification

Kingdom	Plantae (Bitkiler)
Section	*Magnoliphyta* (Kapalı tohumlular)
Clade	*Liliopsida* (Bir çenekliler)
Family	*Poaceae* (Buğdaygiller)
Subfamily	*Pooideae*
Order	*Poales*
Genus	*Thinopyrum*
Species	*Thinopyrum ponticum*

Scientific classification of tall wheatgrass is given in Table 2. The tall wheatgrass is in the family of wheatgrass (Poaceae(=Gramineae) and is from the Pooideae subfamily. The origin of the tall wheatgrass is an important part of Turkey, the Mediterranean Basin and Russia. It was taken from Turkey to the USA in 1909 and is now found in all western countries, in many regions of the UNITED States and Canada (Weintraub, 1953; USDA, 2008; Barkworth et al., 2007). A long-lived, perennial plant, the tall wheatgrass is a tall (90-180 cm), erectly developed, coarsely structured, hard and soft-forming plant (Duke, 1983).



Figure 1: Tall wheatgrass (Anonymous, 2015)

In the early stages of development, this hardness and erection are even more pronounced. Its blue-green colored, hairiness or hairless leaves are curled inward. The auricles are long, narrow, pliers-shaped and embrace each other or narrow to the bottom, taking the form of triangles. The veins of its long leaves, which become coarse in a short time, are pronounced. According to most wheatgrass species, it takes longer to ripen, spike and flower. The flower community is sparsely populated. Since in the peduncle spike between the internod are flat, spiklets appear to be sorted one way. There are many flowers in the spikelets. Spikes are 10-30 cm long,spklets are 1.5-3 cm long. The lower outer glume is 7-9 mm long with 7 veins, the upper outer glume is 8-10 mm and 9-veins, the ends are blunt, the inner glumes are 10-12 mm, 5-veins and without awns. The palea is 8-10 mm long (Bakır, 1970). The hulled fruits are large. The seed is 0.5-1.0 cm long and weighs 1000 grains 5-7 g.



Figure 2. Tall wheatgrass seeds (Anonymous, 2015)

Salty and alkaline meadows, marshes and seasides are natural habitats of these plants. Tall wheatgrass, which has an annual rainfall of 350-400 mm or adapts well to irrigated lands, is highly resistant to heat and cold. Thanks to its deep roots, it is able to withstand temporary droughts and is used for rangeland breeding in arid and semi-arid regions (Garcia et al., 2002). Gençkan (1983) reported that, it can be grown even in the arid regions of Australia where the rainfall is 200 mm. The annual precipitation in the places where it grows is 300-2100 mm, the average annual temperature is 5-19˚C and the pH ranges from between 5.3-9.0 (Duke, 1983). Tall wheatgrass is suitable to be used as a base rangeland, since it grows better in high grazing separation, ground water close to the surface, poor drainage, wet alkaline and salty soils compared to other plants. It adapts to irrigated or saline soils with high groundwater. It even prefers soils with high groundwater (Jensen et al., 2006). It withstands waterlogging very well. Hay yield is high in moist wet areas. It can survive waterlogging caused by heavy rains in the spring for five weeks. The ability of the wheatgrass to grow and maintain itself in moist, medium alkaline soils provides a wide use in restoring these areas. They can adapt to high values up to 10.1 soil pH. Apart from where there is a high amount of salt, they can be used to produce roughage in problem areas (Oram, 1990). The most important feature of tall wheatgrass is that it is resistant to salinity. tall wheatgrass from wheatgrass species yields with a loss of 50% yield at high salinity, where other plant species cannot grow (Özgül, 1974). With these features, these plants are in the class of forage crops that are resistant to salinity (Tekeli and Ateş, 2009). It can grow even in areas with soil

salinity of 26mS cm^{-1} (Ogle et al., 2008). With this feature, tall wheatgrass is a very important forage crops that can be used for breeding salty soils (Altın et al., 2009). Its tolerance to salinity is quite high, especially in wet areas (Crowle, 1966; Forsberg, 1953; Rauser and Crowle, 1963). Tall wheatgrass, suitable for balancing the groundwater level in moderately saline areas, can reduce soil salinity (Bleby et al., 1997). Due to this known feature, it is cultivated in California to help use salty underground drainage water (Zheng et al., 2005). In the study named effects of halomorphic soils conditions on plant numbers emerging in square meter of some perennial forage species it was determined that wheatgrass species showed higher germination and seedling emergence in excessively saline soil conditions compared to type of control (Temel et al., 2015). In a study in which the effect on botanical and yield component in some Agropyron species of different salt concentrations in some wheatgrass species were determined, it was observed that high grassland was less affected by saline conditions than both species. Furtermore in terms of morphological influence, it has been shown that high grassland is more compatible with saline conditions (Koç, 2017). Among the forage species that can grow in saline and alkaline soils, such alfalfa, birdsfoot, white clover, tall wheatgrass, crested wheatgrass, perennial ryegrass, smooth bromegrass, tall fescue, the most durable species has been determined as tall wheatgrass. Considering the height of the plant, the measurements were 14.5 cm and 11.0 cm in thetall wheatgrass grown in normal soil and salt-alkaline soil, respectively (Tan et al., 2002). Its seeds usually germinate very slowly and its seedling growth is slow.

Young seedlings cannot compete strongly with weeds throughout the planting year. For this reason, it should be plant in clean soil in its cultivation. Plants should be allowed to mature and scatter the seeds before harvesting or grazing in the year of planting (Oram, 1990).

If it can be established in both spring and autumn, it is best for autumn. 2.5-3.0 kg da^{-1} for hay production and 2.0-2.5 kg da^{-1} for seed production should be used. Sowing depth should not exceed 2-3 cm. The spacing between rows varies depending on the purpose of cultivation. In arid conditions, it gives good results in row spacing of 50-60 cm for hay and 100 cm for seeds. Due to its late maturation, it is recommended to plant the tall wheatgrass pure sowing rather than intercropping (Asay, 1995). It is planted in pure sowing as a soil and moisture protective plant due to its high special adaptability and its continued development until the end of summer. However, it can be planted mixed with alfalfa and sainfoin in arid conditions, and with alfalfa and red clover in wet conditions. Maintains its greenery until summer. For hay, it should be mown before heading. Its yield is quite high. 300-500 kg of dry herbage can be taken per decare. Yield can reach 1 ton/da in humid regions. 2 tons da^{-1} of dry herbage was taken from some varieties in the irrigated conditions of the GAP Region (Tükel et al., 1993). Tall wheatgrass is a moderately self-fertile plant. Seed production is good in regions with a long growing season.

For the seed, threshing from the bundles by mowing in the yellow dough period reduces the loss of seed. Since there is no uniform maturation in the spike, first mowing and threshing after drying reduces

seed loss. It can also be harvested directly with a combine harvester during the period when the scattered is low. Seed yield of tall wheatgrass varies between 20-50 kg da^{-1}.

Tall wheatgrass is used as hay, silage and grazing, as well as used in the breeding of salty soils. Since it starts to develop early in the spring and stays green for a long time in the summer, it can be used as a rangeland plant. It provides quite high yields in semi-watery conditions or imgated alkaline soils. Its ripening is about a month after the crested wheatgrass. The value of feed is not as high and tasty as others (Duke, 1983). Animals that graze the tall wheatgrass in early spring do not like to eat plants that quickly coarsen afterwards. In these circuits, animals graze tall wheatgrass only if there are no other plants in the environment (Hafenrichter et al.,1968; Kernick, 1978). By siloing the coarse grass of the tall wheatgrass, a softer and tastier feed is obtained.

Good quality dry grass is obtained when the tall wheatgrass is harvested before it is spiked and when it is green. In the early period, the content of digestible proteins and total digestible nutrients is higher than other wheatgrass types. The crude protein value of thetall wheatgrass decreases from 20% in early spring to less than 10% in June and less than 5% in July (Sedivec and Barker, 1998). If harvested in the early period, it is easily consumed by sheep and cattle. Unlike many natural grass, it shows good development and growth after harvesting (Smith et al., 1994). After the first three mowing years, its yield decreases significantly. When planted in a intercropping with legumes, higher quality dry hay and higher grass yields are obtained (Duke, 1983). An

average of 707.4 kg da $^{-1}$ year dry hay was obtained from the binary mixtures with alfalfa for six years (Altın, 1988). Nitrogen fertilizer application at the end of the autumn season before or after the rains may cause more dry matter formation in the next spring season (Lauriault et al., 2002). In a six-year period, 848.5 kg da $^{-1}$ year of hay was taken from the high grass weed planted in 30 cm row spacing and applied 21 (15+6) kg N da^{-1} in Erzurum. The dry herbage yields of this species at 10.5 (7.5+3.0) kg N da^{-1} applications of clover and meadow clover binary mixtures were 815.8 kg da $^{-1}$ year and 795.5 kg da $^{-1}$ year, respectively. In the researches, 800-900 kg da^{-1} dry herbage yield containing 8-10% crude protein was obtained from tall wheatgrass in irrigated conditions (Altın, 1987; Aydın et al., 1994). Kusvuran et al. (2005), conducted a two-year study to determine the adaptation capabilities of alfalfa (*Medicago sativa*) tall wheatgrass (*Agropyron elongatum*) in the ecological conditions of K.K.T.C in 2000 and 2001. As a result of the study, a total of 10828.72 kg da^{-1} of green herbage and 2642.39 kg da^{-1} of dry hay were obtained from alfalfa, and these amounts were 1571.03 kg da^{-1} and 613.73 kg da^{-1} in tall wheatgrass. Researchers have reported that tall wheatgrass has satisfactory yield. In a study investigating the effect of *Agropyron elongatum* (Host) P. Beauv.] on yield, yield components and protein ratio, when different doses of ammonium sulphate fertilizer were applied, 120 kg pure N ha^{-1} and 160 kg pure N ha^{-1} doses were observed in dry herbage yield increased by 30% and 58%, respectively. As a result of the research, the highest protein ratio ranged from 6.47% and 160 kg pure N ha^{-1} ammonium sulfate dose (Acar et al., 2020). Martyniak and Zurek

(2014) reported that tall wheatgrass contains 426 and 586 spiked stems per $m^{2,}$ respectively, when 25-50 cm row spacing is used in a normal sowing rate. In the same study, they reported that the yield of tall wheatgrass varied between 500-900 kg ha^{-1}. Scheinost et al. (2008) reported that the seed yield of tall wheatgrass land in dry conditions was 336 kg ha^{-1}, and in irrigated conditions it had a seed yield of 672 kg ha^{-1}. Vogel and Moore reported that different tall wheatgrass populations comprise between 6.60% and 0.50% crude protein ration and protein yields ranged from 24 g to 48 g per plant. Due to its late maturation, it provides green fodder during a long grazing period. Tall wheatgrass can remain green during this period, in spite of the fact that most plants dry out in the second half of summer. End-of-season grazing can be continued until there are stubbles at a height of 20 cm in order to prevent heavy grazing the following year. In the following year, grazing should not be started before the plant is 25 cm tall (Asay, 1995). It gets rough quickly with the progress of maturation. Animals avoid rough stems as they graze their leaves. It can be used as a rangeland plant because it starts to develop early in the spring and stays green for a long time in the summer. Autumn development is also favorable. Moreover, tall wheatgrass is an important plant grown for the purpose of establishing rangeland in wet and alkaline soils with poor drainage near ground water and also on sandy lands. It not only ensures the improvement of unsuitable lands of this nature, but also allows them to be evaluated as rangeland. It is also of great value in terms of erosion control. Fields that are not heavily grazed or mown from the bottom take on a bushy appearance in a few years. These areas are used as an ideal protection

and reproduction area especially for wild animals. Due to its height and forming a tight ball, it is a nesting area for birds, a food source for birds with its seeds remaining on the plant during periods of heavy snow cover, and a protection area for some farm animals during calving or lambing (Asay and Jensen, 1996). In addition to these, it is a source of resistance to salinity, drought and diseases in soil improvement programs (Asay, 1995). It also provides benefits in controlling wind erosion and managing excessive snowfal.

Result

Tall whatgrass is one of the rare fodder plants that are successfully grown in wet, alkaline, salty soils. It is also of great value in terms of erosion control. For this reason, problematic soils out of agriculture is important in terms of both the improvement of salt affected soils and the quality-roughage production. It is a great deficiency that there is not enough research done in our country on tall wheatgrass. As a matter of fact, there is no registered cultivar in our country. However, considering the advantages of the plant, the studies on this subject should be increased and new cultivars should be developed suitable for the conditions of our country.

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