Agricultural Sciences Journal
Available online at http://asj.mnsuam.net/index.php
ISSN 2707-9716 Print
ISSN 2707-9724 Online

Research Article

ADAPTABILITY OF PROSO MILLET (*PANICUM MILLIACEUM*) IN MULTAN PAKISTAN

Muhammad Abdullah Akber[1], Rao Muhammad Ikram[1*], Shahid Iqbal[1], Khuram Mubeen[1], Muhammad Imran[2], M. Habib Ur Rahaman[1], Wazir Ahmad[2]

[1]*Department of Agronomy, MNS-University of Agriculture Multan Pakistan.*
[2]*Department of Soil and Environmental Sciences, MNS-University of Agriculture Multan Pakistan.*
**Corresponding author: rao.ikram@mnsuam.edu.pk*

ABSTRACT

Crop production is adversely affected by abiotic stresses caused due to climate change. Abiotic stresses have adverse effects on major cereal crop decreasing the yield and quality of produce. Therefore, diversification in existing cropping system is necessary to feed a nutritional food to increasing population. In this scenario, reviving of climate resilient crops like proso millet (Panicum miliaceum) is a viable option. A field experiment was conducted to evaluate the adaptability and yield potential of different proso millet accessions under agro ecological conditions of Multan. Different proso millet accessions were obtained from United States Department of Agriculture. The experiment was conducted at research area of MNS-University of Agriculture, Multan during Kharif season 2018. Seventy accessions were grown manually by hand on ridges with three replications. Data regarding yield related attributes was recorded using standard procedures. Significant variations (51%) were observed among proso millet accessions as depicted by final yield and biomass traits. Thirty accessions produced reasonable biomass as well as seed yield as reported in international reports. Maximum grain yield per plant was observed in accession P36 (16 g) and minimum grain yield was observed in accession P53 (0.3g). In addition, maturity period of prosos millet ranged between 48-75 days. So, this crop can be adjusted in any cropping pattern due to its short season. Proso millet can be used to overcome food security in future in marginal areas.

Keywords: Adaptability, biomass, grain yield, proso millet.

(Received: 30 December 2019, Accepted: 15 April 2020)
Cite as: Akber, M. A., Ikram, R. M., Iqbal, S., Mubeen, K., Imran, M., Rahman, M. H., Ahmad, W. 2020. Adaptability of Proso millet (*Panicum milliaceum*) in Multan Pakistan. Agric. Sci. J. 2(1): 9-15.

1. INTRODUCTION

World population will touch 9 billion by 2050, literature suggests doubling the crop production to meet food demand in future (Ray et al., 2013). Climate change is likely to result in weather extremes, which will make the situation more worse leading to increased incidence of biotic and abiotic stresses (Abraham et al., 2014). Climate change is a big threat to the agriculture. Pakistan is being adversely affected by climate change. In recent past temperature has risen and it is estimated that temperature will rise by 2^{o}C in near future. Increase in temperature will lead to the shortage of water. Continuous with-drawl of water by tube-wells and uncontrolled flood irrigation has increased the salinity of our soils. So, to cope with this scenario of increasing temperature and water shortage and in addition to salinity, we have to change our cropping patterns to ensure food security. Increasing food demand and less production of high yielding crops increasing the risk of food security (Mayes et al., 2011). In recent studies, scientists suggest to increase the consumption of neglected foods to reduce the risk of food security (Khoury et al., 2014). Underutilized crops like amaranth (Amaranthus spp.) and proso millet are highly stable to grow in harsh soils (Abraham et al., 2014). These crops are very

important to sustain human health and considered as super food diets.

Furthermore, revival of cereal crops that were the part of our diet a long ago can help overcome nutrient deficiencies. For this purpose, proso millet can tolerate high temperature, resists drought conditions and can also cope with salinity without compromising on yield. Genus Panicum includes 400 species, in which proso millet is one of the major species (Roshevits, 1980). Approximately 20 species of millet are cultivated in the world. This cereal has high nutritional value and is used in human feed, bird feed, and brewery production. Exclusive features, such as water shortage and heat tolerance, make proso millet a potential substitute cash crop especially for marginal areas. Adaptation of proso millet to dryland areas can help farmers in diversification of wheat-based cropping system. The present study was carried out to screen out elite accessions for further cultivation and use in breeding program in agro ecological conditions of Multan.

2. MATERIALS AND METHODS

2.1. Field Experiment:

A field study was done at agronomic research area of Muhammad Nawaz Shareef University of Agriculture Multan during kharif season 2018 (12-July). The experiment material consisted of 70 proso millet accessions obtained from United State Department of Agriculture (USDA). A fine seed bed was prepared with tractor mounted plow for the sowing of proso millet. The experiment was carried out in a randomized complete block design with three replications. Ridges were made for the sowing of proso millet keeping plant to plant and row to row distance of 45 and 10 cm, respectively. Seed was sown by hand dibbling Soil was supplemented with nutrients nitrogen, phosphorus and potassium by adding @ 60:40:40 NPK respectively, using urea, DAP and potash as fertilizer source. All doses were applied at time of seed bed preparation. Total 3 irrigations were applied during whole course of experimentation. Parameters such as plant height at maturity (cm), total number of basal tillers, hundred grain weight (g), yield (g plant^{-1}), total biomass (g plant^{-1}) and days taken to physiological maturity were recorded. SAS 9.1 software was used to deduce the results from observation in the form of ANOVA. Means are presented in bar graphs along with standard errors bars.

3. RESULTS

Statistically significant variations were ($P \leq 0.001$) observed among tested accession of proso millet for plant height trait. Moreover, genotypes P1, P5, P8, P32, P7 and P33 had maximum plant height (100-110 cm), while genotypes P17, P18 and P29 had minimum plant height (40-45 cm) and remaining genotypes comes in range of 40- 80 cm plant height as shown in fig. 1.

Statistically significant differences ($P \leq 0.001$) were observed among genotypes for number of tillers basal tillers. Moreover, genotypes P2, P5, P61, P63 and had P25 produced maximum tillers (18-20 tillers), genotypes 41,16 and 36 had minimum tillers (3-5 tillers) and remaining genotypes had tillers in range of 10- 16 tillers as shown in fig2.

Significant variations were ($P \leq 0.001$) observed among tested accession of proso millet for hundred grain weight traits. Moreover, genotypes P3, P12, P40, P53 and P69 had maximum hundred grain weight (0.82 g), genotypes P9, P26, P48 had minimum hundred grain weight (0.24- 0.32 g) and remaining genotypes has range of hundred grain weight (0.55 – 0.68 g) as it is shown in fig 3.

Analysis of variance for yield showed that all accessions were significant in exploring the adaptability of proso millet under agro-climatic conditions of Multan. Moreover, genotypes P36 (16 g) and P27 (13 g) had

maximum seed yield per plant; genotypes P53 (0.3 g) and P63 (1.03 g) had minimum seed yield per plant and remaining genotypes have seed yield in range of 8 – 11 g as shown in fig. 4.

Significant variations were ($P \leq 0.001$) observed among tested accession of proso millet for biomass trait. Moreover, genotype P32 had maximum biomass per plant (140 g) and genotype P53 had minimum biomass per plant (30 g) as shown in fig. 5.

Significant statistical variations ($P \leq 0.001$) were observed among genotypes to reach physiological maturity stage (fig 6). Moreover, except genotypes P26 P27, P36 all genotypes matured at same time. Above mentioned genotypes were found to be late maturing.

4. DISCUSSION:

To address problems of climate change (drought and heat spells) and malnutrition, there is dire need of crop diversification which means introduction of new crops and revival of old crops for future food security. Therefore, this experiment was conducted to explore adaptability of exotic proso millet germplasm in agro-climatic conditions of Pakistan. Total 70 exotic accessions of Proso millet were imported from USDA to explore adaptability. Crop was sown in peak summer season on July 12, 2018 and this period is main warm season of the country. Most of the genotypes survived in this harsh condition and produced reasonable biomass less inputs as mentioned in material and methods which indicated that these accessions had climate resilient behavior. Villa, 2003 also wrote about stress tolerance of proso millet under harsh climate and declared this crop as drought and heat tolerant.

The important agro-morphological attributes of crop are plant height and generally it displays the relative growth and vigor of crop plant. In current study accession number 1, 5 had maximum plant height and accession number 17 and 18 has minimum plant height it depicts that proso millet plant gained desired height according to its inherent character in local conditions and which is close conformity of Salini, 2010 study. Tillering also play an important role in proso millet yield enhancement. In current study, it was observed that some accessions produced 18-20 tillers/plant and some accessions produced 3-5 tillers/plant Similar findings also reported by Turgut, 2006. Another important yield regarding parameter is 100 grain weight. In this study, it was ranging from 0.42 – 0.82 g which is similar to findings of Salin, 2010.

The most important attribute of a crop is grain yield per plant. Biomass is directly influencing the grain yield in proso millet (Maman *et al*., 2003). In this study, data regarding biomass showed that maximum value was 140 g per plant and minimum was 30 g. There were significant differences in grain yield. Accession number 36, 26 and 27 were found high seed yielder It might be due to difference in accessions potential because all accessions are not from same origin. Principally, grain yield is depending on number of tillers, plant height, hundred grain weight and biomass Shanahan *et al*., 1985.

But in our case, it seems different as mentioned in material and method section crop was grown in peak summer season and accessions experienced high temperature and showed different adaptability. Accessions which produced high grain yield can be heat tolerant as well. Grain yield can also be result of association and expression of many plant

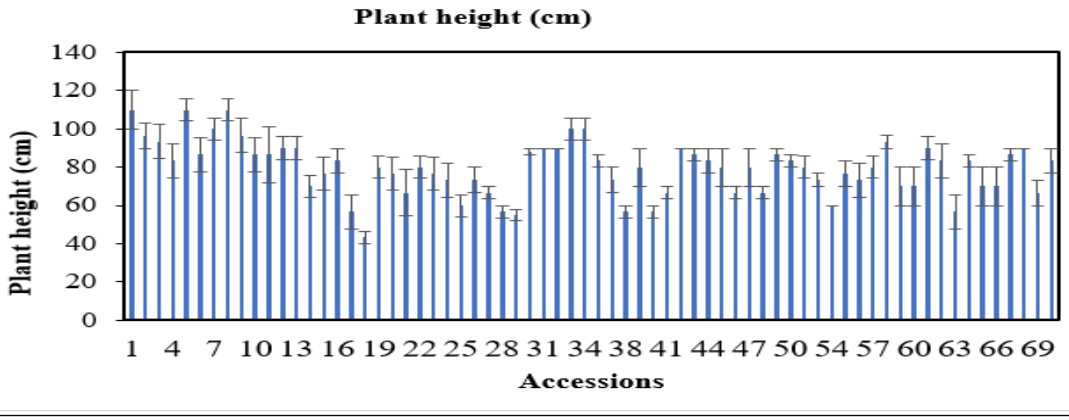

Fig. 1. Plant height of various proso millet accessions grown under agro-climatic conditions of Multan, Pakistan

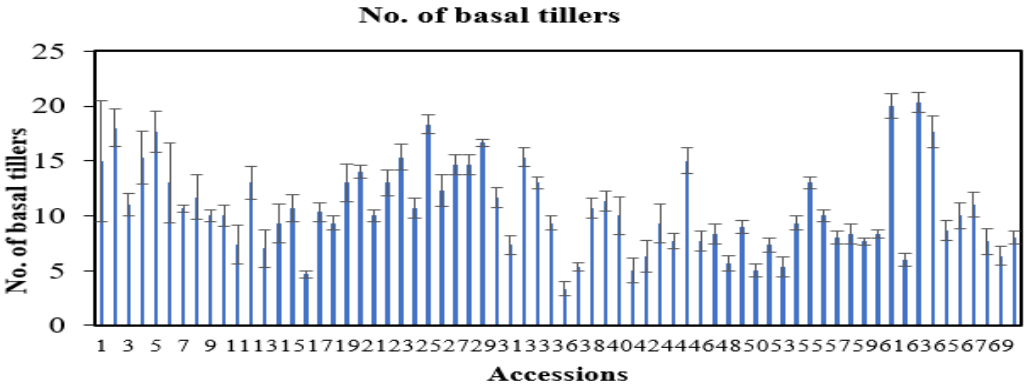

Fig. 2 Number of basal tillers of proso millet accessions grown under agro-climatic conditions of Multan, Pakistan

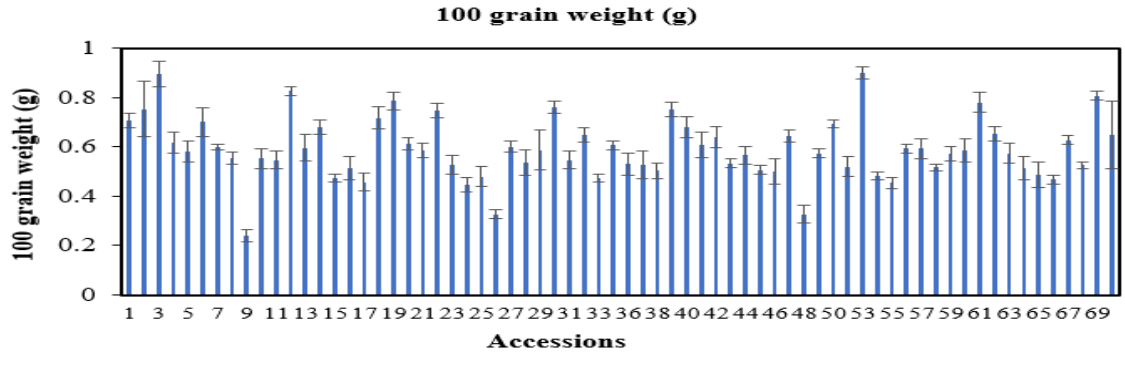

Fig. 3 100 grain weight of proso millet accessions grown under agro-climatic conditions of Multan, Pakistan

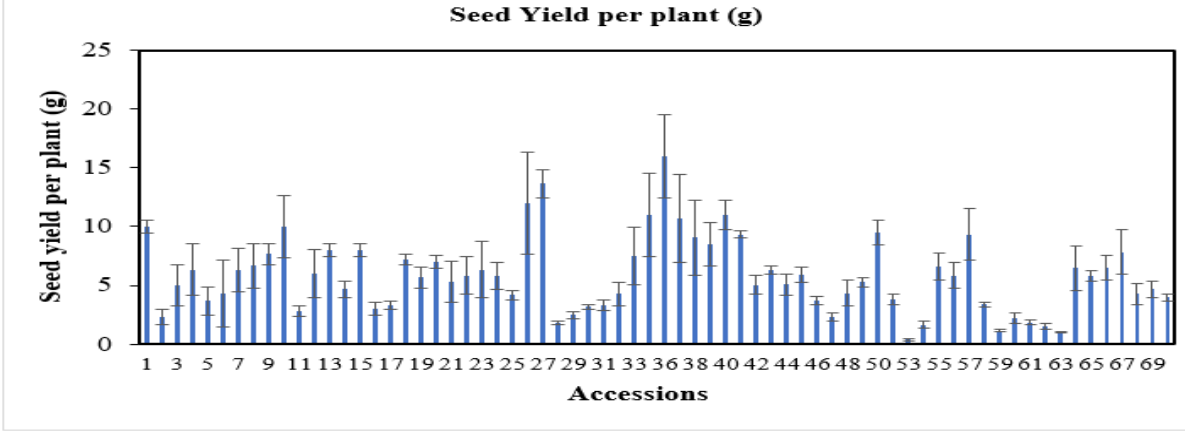

Fig. 4 Seed yield per plant of proso millet accessions grown under agro-climatic conditions of Multan, Pakistan.

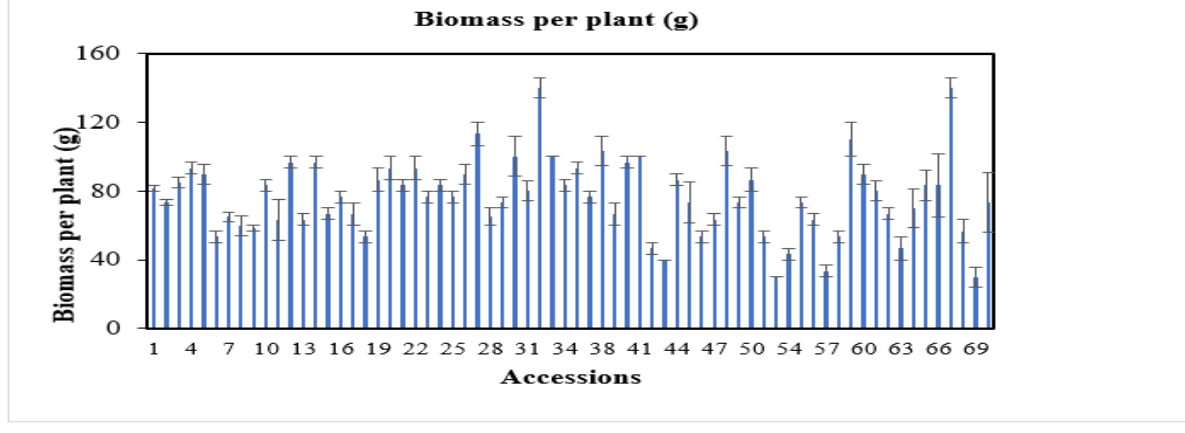

Fig. 5 Biomass per plant of proso millet accessions grown under agro-climatic conditions of Multan, Pakistan.

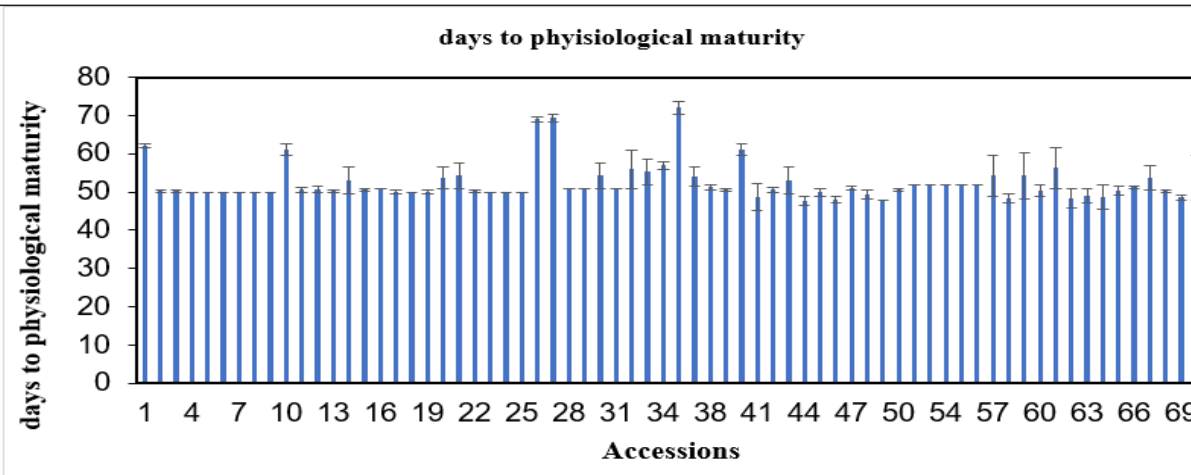

Fig. 6 Days to physiological maturity of proso millet accessions grown under agro-climatic conditions of Multan, Pakistan.

growth components and environmental conditions (Anjum et al., 2011). Abiotic stresses such as high temperature is also most important factor which restricts growth and productivity of major cereals (Shwabe et al., 2013, Umar, 2006).

Furthermore, it is evident from time of physiological maturity (fig 6) that accessions which were high yielder matured late, if can be linked to "stay green" character of accession, stay green character has been considered an important character for heat tolerance. It has also been observed that heat tolerant wheat genotypes had also chlorophyll contents (Farooq et al., 2011) which is directly linked to stay green character, moreover adapted accession might also have good antioxidant system to detoxify toxic ROS which may otherwise be detrimental to macro molecules including chlorophylls (Sharma et al., 2012). The grain filling process is a reserve accumulation in developing grain which is sensitive to environmental factors which ultimately affect final seed yield (Yang and Zhang, 2006). The most significant factor limiting seed yield is high temperature in cereals, high temperature induces shortening of vegetative phases, less light perception due to shortened life cycle and perturbation of carbon assimilation processes (photosynthesis, transpiration and respiration) (Stone 2001). So, it seems that low yielder accessions were heat sensitive that's why they mature earlier (fig 6). Heat stress induces metabolic changes especially excess ethylene production leading to early senescence and chlorophyll degradation. Thus, maintenance of stay green character is very important and considered as best indicator of thermo tolerance (Farooq et al., 2011). Furthermore, grain yield also depends upon flag leaf size and its chlorophyll contents (Farooq et al., 2011) which should be considered in future studies of accessions screening. Phenological traits have key importance in crop production it directly influences the overall yield of a crop. In current study days taken to physiological maturity were recorded. It was observed that most of the genotypes reached at physiological maturity stage in 48 to 75 days which shows that it is a short duration crop.

5. CONCLUSION:

In this preliminary study, out of 70 tested accessions of proso millet, 8 accessions (#26, 27, 36, 1, 10, 34, 37, 40) were found adaptable for Multan Pakistan conditions. Their adaptability was linked with stay green character. Cultivar development and genetic improvement of proso millet can be initiated by selecting these adaptable accessions and it will also need further testing in multiple locations to explore yield potential.

6. REFERENCES

Abraham, B., H. Araya, T. Berhe, S. Edwards, B. Gujja, R. B. Khadka, Y. S. Soma, D. Sen, A. Sharif, E. Styger, N. Uphoff and A.Verma. 2014. The system of crop intensification: reports from the field on improving agricultural production, food security, and resilience to climate change for multiple crops. Agric. Food Security. 3:1-12.

Anjum, S.A., X.Y. Xie, L.C. Wang, M.F. Saleem, C. Man and W. Lei. 2011. Morphological, physiological and biochemical responses of plants to drought stress. Afr. J. Agric. Res. 6:2026-2032.

Amanullah, J., I. Khan, S. Ali and A.A. Sohail. 2012. Sowing Dates and Sowing Methods Influenced on Growth Yield and Yield Components of Pearl Millet under Rainfed Conditions, J. Envron. Earth Sci. 5:104-107.

Farooq, M., H. Bramley, J.A. Palta and K.H.M. Siddique. 2011. Heat stress in wheat during reproductive and grain-filling phases. Crit. Rev. Plant Sci. 30:1-17.

Khaliq, I., A. Irshad and M. Arshad. 2008. Awn and flag leaf contribution towards grains yield in spring wheat (Triticum aestivumL.). Cereal Res. Commune.36:65-76.

Khoury, C. K., A. D. Bjorkman, H. Dempewolf, J. Ramirez-villegas, L. Guarino, A. Jarvis, L. H. Rieseberg and P. C. Struik. 2014. Increasing homogeneity in global food supplies and the implications for food security. Proceed. Nation. Acad.Sci. United States America. 111:4001-4006.

Maman, N., D.J. Lyon, S.C. Mason, T.D. Galusha and R. Higgins. 2003. Pearl millet and grain sorghum yield response to water supply in Nebraska. Agron. J. 95:1618-1624.

Mayes, S., F. J. Massawe, P. G. Anderson, J. A. Roberts, S. N. Azam-Ali and M. Hermann. 2011. The potential of underutilized crops to improve security of food production. J. Exp. Bot. 63: 1075-1079.

Ray, D. K., N. D. Mueller, P.C. West and J. A. Foley. 2013. Yield trends are insufficient to double global crop production by 2050, PLoS one. 8: 1-8.

Roshevits., R.Y. 1980. Grasses: an introduction to the study of fodder and cereal grasses.

Sharma, P., A.B. Jha, R.S. Dubey and M. Pessarakli. 2012. Reactive Oxygen Species, Oxidative Damage, and Antioxidative Defense Mechanism in Plants under Stressful Conditions. J. Bot. 2012:1-26.

Shwabe, K., J. Albiac-Mutillo, J.D. Connor, R. Hassan and G.L. Meza. Drought in Arid and Semi-Arid Regions; Springer: Dutch, The Netherlands. 2013.

Salini, K., A. Nirmalakumari, A. R. Muthiah and N. Senthil. 2010. Evaluation of proso millet (*Panicum miliaceum* L.) germplasm collections. Electron. J. Plant Breed. 1:489-499.

Shanahan, J.F., K.J. Donnelly, D.H. Smith and D.E. Smika. 1985. Shoot development properties associated with grain yield in winter wheat. Crop Sci. 25:771-775.

Stone, P. and A.S. Basra. 2001. The effects of heat stress on cereal yield and quality. In Crop Responses and Adaptations to Temperature Stress. Food Products Press: Binghamton, NY, USA, pp. 243-291.

Umar, S. 2006. Alleviating adverse effects of water stress on yield of sorghum, mustard and groundnut by potassium application. Pak. J. Bot. 38:1373-1380.

Turgut, I., A. Duman, G.W. Wietgrefe and E. Acikgoz. 2006. Effect of seeding rate and nitrogen fertilization on proso millet under dry land and irrigated conditions. J. Plant Nutr. 29:2119-2129.

Villa-Castorena, M., A. L. Ulery, E.A. Catalán-Valencia and M. D. Remmenga. 2003. Salinity and nitrogen rate effects on the growth and yield of chile pepper plants. Soil Sci. Society America J. 67: 1781-1789.

Yang, J.C. and J.H. Zhang. 2006. Grain filling of cereals under soil drying. New Phytol. 169:223-236.