

indirect effect through days to 50% flowering, ear head length and seed set per cent. Days to 50% flowering and anthesis had positive indirect effect through plant height, but a negative indirect impact through ear head length and seed set per cent. The seed set per cent had indirect but positive impact through days to 50% flowering and ear head length. Similarly, positive indirect effect of ear head length was observed through days to 50% flowering and seed set per cent.

Overall, on the basis of average seed set per cent, reduction in seed set and grain yield it can be concluded that hybrids performed relatively better than population. Though hybrids are the most suited type of cultivars, considering the increasing cost of hybrid seed production some high yielding population (like CZP 9603) that are suitable for local conditions could provide the farmers with a sustainable alternative, specifically in the arid regions.

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References

- Bhattacharjee, S.: Involvement of calcium and calmodulin in oxidative and temperature stress of *Amaranthus lividus* L. during early germination. *J. Environ. Biol.*, **30**, 557-562 (2009).
- Cicchino, M., J. I. Rattalino, M. Uribealdea and M. E. Otegui: Heat stress in field-grown maize: Response of physiological determinants of grain yield. *Crop Sci.*, **50**, 1438-1448 (2010).
- Dewey, D. R. and K. H. Lu: A correlation and path coefficient analysis of components of crested wheat grass seed production. *Agron. J.*, **51**, 515-518 (1959).
- Fisher, R. A. and R. Maurer: Drought resistance in spring wheat cultivars. I. Grain yield responses. *Aust. J. Agric. Res.*, **29**, 897-912 (1978).
- Gupta, S. K., K. N. Rai, P. Singh, V. L. Ameta, S. K. Gupta, A. K. Jayalekha, R. S. Mahala, S. Pareek, M. L. Swami and Y. S. Verma: Seed set variability under high temperatures during flowering period in pearl millet (*Pennisetum glaucum* L. (R.) Br.). *Field Crops Res.*, **171**, 41-53 (2015).
- Gupta, D., R.K. Mittal, A. Kant and M. Singh: Association studies for agro-physiological and quality traits of triticale X bread wheat derivatives in relation to drought and cold stress. *J. Env. Biol.*, **28**, 265-269 (2007).
- Jukanti, A.K., C.L.L. Gowda, K.N. Rai, V.K. Manga and R.K. Bhatt: Crops that feed the world 11. Pearl millet (*Pennisetum glaucum* L.): an important source of food security, nutrition and health in the arid and semi-arid tropics. *Food Sec.*, **8**, 307-329 (2016).
- Nelson, G.C., M. W. Rosegrant, J. Koo, R. Robertson, T. Sulser, T. Zhu, C. Ringler, S. Msangi, A. Palazzo, M. Batka, M. Magalhaes, M. Valmonte-Santos, M. Ewing and D. Lee: Climate change impact on agriculture and costs of adaptation. In: Food Policy Report, International Food Policy Research Institute (IFPRI), Washington D.C, USA, p. 19 (2009).
- Prasad, P. V. V., K. J. Boote, L. H. Allen, J. E. Sheehy and J. M. G. Thomas: Species, eco-type and cultivar differences in spikelet fertility and harvest index of rice in response to high temperature stress. *Field Crops Res.*, **95**, 398-411 (2006).
- Rattalino Edreira, J. I. and M. E. Otegui: Heat stress in temperate and tropical maize hybrids: differences in crop growth, biomass partitioning and reserves use. *Field Crops Res.*, **130**, 87-98 (2012).
- Rattalino Edreira, J. I., E. B. Carpici, D. Sammarro and M. E. Otegui: Heat stress effects around flowering on kernel set of temperate and tropical maize hybrids. *Field Crops Res.*, **123**, 62-73 (2011).
- Reddy, A. R., P. Parthasarathy Rao, O. P. Yadav, I. P. Singh, N. J. Ardeshta, K. K. Kundu, S. K. Gupta, R. Sharma, G. Sawargaonkar, D. P. Malik, D. Shyam Moses and S. K. Reddy: Prospects for kharif (rainy season) and summer pearl millet in Western India. Working Paper Series No. 36. International Crops Research Institute for the Semi-Arid Tropics, Patancheru, Andhra Pradesh, India, p. 24 (2013).
- Suwa, R. H., H. H. Hakata, H. A. El-Shemy, J. J. Adu-Gyamfi, N. T. Nguyen, S. Kanai, D. A. Lightfoot, P. K. Mohapatra and K. Fujita: High temperature effects on photosynthate partitioning and sugar metabolism during ear expansion in maize (*Zea mays* L.) genotypes. *Plant Physiol. Biochem.*, **48**, 124-130 (2010).
- Talukder, A. S. M. H. M., G. K. McDonald and G. S. Gill: Effect of short-term heat stress prior to flowering and early grain set on the grain yield of wheat. *Field Crops Res.*, **160**, 54-63 (2014).
- Thakur, R. P. and S. B. King: Ergot disease of pearl millet. In: Information Bulletin No.24. International Crops Research Institute for the Semi-Arid Tropics, Patancheru, Andhra Pradesh, India, p. 24 (1988).
- Yadav, O.P., K. N. Rai, B. S. Rajpurohit, C. T. Hash, R. S. Mahala, S. K. Gupta, H. S. Shetty, H. R. Bishnoi, M. S. Rathore, A. Kumar, S. Sehgal and K. L. Raghvani: Twenty-five years of pearl millet improvement in India. All India Coordinated Pearl Millet Improvement Project (AICPMIP), Jodhpur, India (2012).
- Yadav, A.K., R. K. Arya and M. S. Narwal: Screening of pearl millet F1 hybrids for heat tolerance at early seedling stage. *Adv. Agric.*, **2014**, 1-17 (2014).