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Optimization of deficit irrigation and nitrogen fertilizer management for peanut production in an arid region

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Deficit irrigation (DI) has been emerging as an important technique for enhancing crop water productivity (WP). However, advantage of DI under varying nitrogen (N) application rates remains unclear. Field experiments were conducted during 2012–2014 to investigate the impacts of six irrigation levels[FI (full irrigation), DI_{10}, DI_{20}, DI_{30}, DI_{40} and DI_{50}, with irrigation amount of 100, 90, 80, 70, 60 and 50% of ETc, respectively) and four N application rates (N_0, N_{10}, N_{20} and N_{30}, with 0, 10, 20 and 30 kg N ha^{-1}, respectively) on WP, yield, quality, and net economic return of peanut in hot arid region of India. We used Technique for Order Preference by Similarity to an Ideal Solution (TOPSIS) method to obtain the optimal combination of irrigation and N rates. Both irrigation level and nitrogen dose had significant effects on yield and quality parameters examined in the study. Relative to FI, DI_{40} and DI_{50} significantly reduced yield (40.2–62.1%), economic benefit (70.8–118.5%), WP (8.2–33.0%), and kernel oil content (7.5–11.9%), but DI_{20} increased WP by 17.1% with only marginal reduction in economic benefit (2.6%), and yield (3.2%). Compared to N_0, the N_{30} had 1.7, 1.1, and 1.6-folds increased yield, oil content in the kernel, and WP, respectively. Among all treatments, DI_0N_{30} had the greatest yield and net return; $DI_{20}N_{30}$ had greatest WP and oil content in the kernel. TOPSIS analysis showed that $DI_{20}N_{30}$ was optimal in balancing of WP, yield, net return, and quality of peanut in northwestern arid India. The results have direct implications for improving irrigation water and N management for irrigated crops in arid regions.

Demand for agricultural products will further increase[1] to satisfy the needs of an increasing population. However, the availability of water for agriculture has been declining due to an increasing demand of water for non-agricultural sectors[1,2]. Shortage of irrigation water is seriously affecting agricultural production particularly in arid and semi-arid regions because irrigated agriculture is required for agricultural production in these regions. In the light of diminishing water resources for agriculture and increasing demand for crop production, irrigation strategies need to be devised to maximize crop water productivity (WP)[3]. Deficit irrigation (DI) which involves an application of the amount of irrigation water lesser than the full crop evapotranspiration (ET) is emerging as an important technique to enhance WP[4,5]. It had been reported that DI increased WP with considerable saving of irrigation water in many crops particularly in arid and semi-arid regions[6–9]. Adu et al.[10] reported huge variations in yield response of different crops while analysing relative yield performances of 43 crops grown in 14 countries under DI and full irrigation (FI) suggesting that DI require crop and region specific information on suitable magnitude of irrigation deficit.Thus, implementation of DI requires crop specific information related to identification of suitable magnitude of irrigation deficit, and agronomic management for its effective use[11].

The crop yield and WP are affected by climate, crop species, soil, crop management practices, and choice of cultivar[12–14]. Li et al.[14] reported that agronomic practices influenced WP more than climatic factors; and from among various agronomic management, fertilizer rate and irrigation contributed 42.3% and 32.8%, respectively to the increase of WP. Soil nutrients directly influence photosynthesis and improve utilization of water by crops[13,15].

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