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The Effect of Different Subsurface Drainage Systems on Improvement of Water Flow in Paddy Fields

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Introduction: Better use of water and soil resources in paddy fields, increase in rice production and farmer's income, installation of subsurface drainage system is necessary. The main goalof these systems, are aeration conditions improvement prevention of water logging, yield increase, land use increase and multiuse of the land. In different countries, installation of subsurface drainage cause yield increase and working condition on the land, but no research has been conducted in different depths and spacing. On the other hand, spacing and depth are the most important parameters in the installation of drainage systems, have a direct effect on incoming water into the drains. The aim of this research, is an investigation of the effect of subsurface drainage with different depths and spacing on discharge rate variation and water table fall, in order to analyze the improvement of water flow movement in the soil. Also, study the effect of different drainage systems on the increase of the canola yield as the second cultivation in these treatments have been compared.

Materials and Methods: To measure hydraulic conductivity in different depths, the auger holes have been dug (excavated). The saturated hydraulic conductivity in these holes wasdetermined using Ernst method (1950) before installation of drainage systems. In the drainage pilot plot of Sari Agricultural Sciences and Natural Resources University three subsurface drainage systems with mineral envelope have been installed. 1- The first one with the 0.9 m depth and 30 m spacing (D_{90} L_{30}), 2- The second one with 0.65 m depth and 15 m spacing ($D_{0.65}$ L_{15}) and 3- The third one with 0.65 m depth and spacing ($D_{0.65}$ L_{30}) and one bi-level system with mineral envelope including four drains of 15 m spacing with 0.9 m and 0.65 m depths were installed alternatively. After auger hole equipment installations, in the middle spacing of two subsurface and water table reading possible, the water table fluctuation and drain outlet discharge rate from farm drains during canola growing season were measured on a daily basis. Also, canola yield during 4 years after drainage systems were monitored.

Results and Discussion: The results showed that mean discharge rates of drainage systems have increased with time and in the fourth year it was better than first and second years. Duringthe second year, the highest discharge rate onthe first day was in the low depth treatment and after 3 days the discharge rates become the difference among less. In the third year, the discharge rates of high spacing drains ($D_{0.65}$ L_{30}) have become higher than of spacing drains ($D_{0.65}$ L_{15}) discharge rates. But, in the first day its discharge rate was less and one can conclude that it is due to horizontal flow. With passing time and soil structure improvement, one can observe better yield from drains with higher spacing (30 m) also. By performance of drainage and soil conditions improvement in the third and fourth year, the deeper drainage systems have becomes better and water table fall of deep drain discharge rate and soil condition improvement in these systems become higher. In bi-level drainage, by increasing deep percolation, the water table fall in this treatment increased with time. Also, based on monitoring water table, in the first and second years after 5th day and in the third and fourth years after 4th day the water tables of deep drains decreased to lower depth drains. Due to heavy soil in paddy fields and existence of hardpan, the performance of low depth drains in falling water table was better in the first years. With passing time and performance of drainage the conditions for water movement in the soil become better and performance of deep drainage systems improved and at the fourth year, deep drainage systems had better performance in draining water with respect to low depth drainage systems. Also, canola yield as second cultivation, has increased from first to fourth year and along with important of soil aeration conditions and performance of drainage systems, the grain yield hasincreased in different drainage treatments. The results showed a direct relationship between improvement of system performance and increase in grain yield. In the second year, grain yield increased in all treatments. On the other hand, the yield under drainage systems with deeper depth ($D_{0.9}$ L_{30}) even higher in the 2nd and 4th years than with low depth drain ($D_{0.65}$ L_{30}). This was because of more fall in water table levels during days after rainfall and also with next rainfall, saturation of soil up to surface layer in the plots with deeper drains were performed later and it may not reach up to thesoil surface.

Conclusion: Due to betterconditions of deep drains and with higher spacing in the improvement of paddy

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field use and also less environmental harm use of drains with higher spacing are recommended for these lands. On the other hand,a low increase in drain depth from 0.65 m to 0.9 m along with increase in spacing of30 m with respect to 15 m and even with 0.65 m depth, will have less cost. Due to decrease in the costs of drain installation with higher spacing, due to improvement of conditions, the performance of these systems in 2 to 3 years one can have cheaper drainage systems in the longest time and will improve the economic situation of farmers due to higher yield.

Keywords: Canola yield, Drain depth, Drain discharge, Drain spacing, Water table