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Studies on drip fertigation on growth, yield and pest incidence of American cotton (*Gossypium hirsutum* L) and *desi* cotton (*Gossypium arboreum* L) on sandy loam soil

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ABSTRACT: A field experiment was conducted to find out optimum fertigation schedule through drip in American and *desi* cotton for three consecutive years on sandy loam soil of Sriganganagar. The application of 100 per cent recommended dose of N (150 kg N/ha) and K (20 kg K_2O/ha) in six equal splits at an interval of 15 days to American cotton gave significantly highest seed cotton yield. This treatment gave 49.8 per cent higher seed cotton yield over recommended practice. It gave the maximum number of bolls/plant, boll weight and seed index. The maximum water use efficiency was also recorded with this treatment. It gave higher fertilizer use efficiency in comparison to recommended practice. The average whitefly/leaf and the percentage infestation of spotted bollworm were significantly less in fertigation treatments in comparison to recommended practice. Fertigation improved the quality of lint. In *desi* cotton, drip irrigation at 0.8 and 1.0 ETc did not differ significantly in seed cotton yield, boll weight and plant population. The average effect of drip irrigation was found significantly superior over surface irrigation in terms of yield attributes, seed cotton yield and water use efficiency. Drip irrigation increased seed cotton yield by 27.5 per cent over the recommended practice. The application of 75 per cent recommended dose of N gave *at par* yield with 100 and 125 per cent recommended dose. The application of nitrogen in six equal splits at an interval of 15 days was found *at par* with 9 equal splits at an interval of 10 days. The maximum water use efficiency (3.44 kg/ha mm) was recorded with drip irrigation at 0.8 ETc. The incidence of whitefly and per cent infestation of spotted bollworm was significantly less in drip irrigated treatments in comparison to recommended practice.

Key words: Cotton, drip fertigation, pest incidence, water use efficiency, yield

Cotton is the major *kharif* crop in irrigated north western plain zone of Rajasthan. Cotton is grown in this region under canal command of the Gang, Bhakra and Indira Gandhi canals. The conventional irrigation method in cotton leads to enormous losses of water through evaporation, seepage and deep percolation which leads to the development of salinity, water logging and leaching of nutrients in canal commands. The lower yields of cotton could be attributed to inefficient irrigation and fertilizer management practices (Veeraputhiran and Chinnusamy, 2009). Drip irrigation and fertigation are technologies which improve both water and fertilizer use efficiency to a great extent. Fertilization must always supply and maintain an optimum level of nutrients within the root zone for good growth and harvesting of potential yield of crops. An effort has been made in the present investigation to find out the optimum fertigation schedule for American and *desi* cotton on sandy loam soil of irrigated north western plain zone of Rajasthan.

MATERIALS AND METHODS

A field experiment was conducted on drip fertigation in American cotton (*kharif*, 2002 to 2004) and *desi* cotton (*kharif*, 2005 to 2007) at Agricultural Research Station, Sriganganagar. The soil of experimental site was sandy loam in texture, low in organic carbon (0.28%), medium in available phosphorus (32 kg P2O5/ha) and high in available potash (330 kg K2O/ha). The average values for volumetric moisture content at field capacity and permanent wilting point were 0.198 and 0.072 m3 /m3, respectively. Five treatments comprising of a combination of two doses of fertilizer (100 and 75 per cent recommended dose of fertilizer N and K) and two levels of split application of fertilizers (4 splits at an interval of 20 days and 6 splits at an interval of 15 days) along with one control treatment of recommended practice (RP) of fertilizer application with flood method of irrigation were tested in American cotton. Thirteen treatments comprising of a combination two levels of drip

irrigation (0.8 and 1.0 ETc), three levels of nitrogen (75, 100 and 125 per cent recommended dose of N) and two levels of split application of nitrogen (6 splits at an interval of 15 days and 9 splits at an interval of 10 days) along with control treatment of recommended practice (RP) of fertilizer application with flood method of irrigation were tested in *desi* cotton. The experiment was conducted with randomized block design in American cotton and with factorial randomized block design in *desi* cotton. Both *hirsutum* and *arboreum* cottons were sown in paired rows having 60 cm distance within pair and 120 cm distance between pair. Drip line having dripper to dripper distance 30 cm and discharge of each dripper 2 LPH was placed within the pairs. Irrigation through drip was applied on alternate day as per recommended schedule at 1.0 ETc in *hirsutum* and as per irrigation treatments in *arboreum* cotton. The recommended dose (RD) of N, P2O5 and K2O in American cotton was 150, 40 and 20 kg/ha, respectively. Nitrogen and potash was applied through drip in American cotton as per treatments. The recommended dose of N and K2O in *desi* cotton was 90 and 20 kg/ha, respectively. Nitrogen was applied in *desi* cotton through drip as per treatments. Full dose of phosphorus was applied at sowing as basal in both the crops. The treatmentwise yield, yield attributing parameters and insect pest infestation data of both the trials were recorded. The data were statistically analyzed and inferences were drawn.

RESULTS AND DISCUSSION

American cotton

Plant population and plant height: The effect of different treatments on plant population and plant height was found significant (Table 1). The minimum plant population was recorded with recommended practice of irrigation and fertilizer application. The optimum time of sowing of American cotton in this region is May. The temp during the month of May goes as high as 48 °C at which plant mortality is a common feature. In surface irrigation method, first irrigation in cotton is applied at 30-35 days after sowing and during this period plant mortality occurs. Under drip irrigation due to availability of water on alternate day sufficient moisture remains in soil and soil surface temp remains lower. Therefore, negligible mortality was observed under drip fertigation treatments. The maximum plant height at 90 days after sowing was recorded at 100 per cent RD in 6 splits, whereas, the minimum plant height was recorded under recommended practice. The availability of irrigation water and nutrients as per requirement of the plants under fertigated treatments may be responsible for better plant height.

Yield attributes and yield: Different treatments significantly influenced bolls/plant, boll weight, seed index and seed cotton yield (Table 1). The bolls/plant was significantly higher in fertigated treatments in comparison to recommended practice. The bolls/plant, boll weight, seed index and seed cotton yield was recorded under 100 per cent recommended dose of fertilizers through drip in six equal splits. The minimum seed cotton yield was recorded with recommended practice. The average increase in seed cotton yield due to 100 per cent RD in 6 splits was 49.8 per cent over recommended practice. Increase in growth and yield attributes as a result of optimum moisture and nutrition to the crop through drip fertigation was due to increased photosynthates and translocation of more assimilates from source to sink (Raskar, 2004; Veeraputhiran and Chinnusamy, 2009). Consequent upon favourable effects on growth and yield attributes due to water and fertilizer application as per need of the crop through drip, significantly higher seed cotton yield was recorded under fertigation (Raskar, 2004).

Incidence of pests: The average number of whitefly and per cent infestation of spotted bollworm were significantly influenced by different treatments (Table 1). The incidence of whitefly was lower in drip fertigated treatments in comparison to recommended practice. Among drip fertigated treatments lower incidence of whitefly was recorded at 75 per cent RD than 100 per cent RD. The per cent infestation of spotted bollworm was higher in recommended practice than drip fertigated treatments. Similar to the incidence of whitefly, the per cent infestation of

spotted bollworm was more under 100 per cent RD than 75 per cent RD of fertilizers.

Desi cotton

Plant population: The effect of different treatments on plant population was found non significant except the average effect of drip and surface irrigation (Table 2). In drip irrigated plots plant population was significantly higher over flood irrigated plots. The optimum time of sowing of *desi* cotton in irrigated north western Rajasthan is April month. The temp during the month of April and May goes as high as 48 °C at which plant mortality is a common feature. Under drip irrigation due to availability of water on alternate day sufficient moisture remains in soil and soil surface temp remains lower. Therefore, negligible mortality was observed under drip fertigation treatments. In surface irrigation treatment first irrigation was applied at 35-40 days after sowing and due to higher temperatures mortality was observed.

Yield attributes and yield: The different drip irrigation levels significantly influenced only the bolls/plant. The more bolls/plant were recorded when irrigation was scheduled at 1.0 Etc, however, seed cotton yield was *at par* in both the treatments. Thus, irrigation scheduled at 0.8 ETc was found sufficient for *desi* cotton. The average effect of drip irrigation gave significantly more bolls/plant and higher seed cotton yield. The average increase in seed cotton yield due to drip irrigation was to tune of 22.3 per cent over that of surface irrigation. The different doses of nitrogen (75, 100 and 125% N) as well as split application of nitrogen (6 and 9 splits) did not influence yield attributes and seed cotton yield (Table 2). Thus, 75 per cent recommended dose of N (67.5 kg N/ha) in six equal splits at an interval of 15 days was found optimum for *desi* cotton. Plant population was maintained in drip irrigation treatments, whereas in flood irrigation treatment mortality of plants due to high temp and hot winds was observed during initial growth stage. Under drip irrigation, water is released strictly in the root zone drop by drop in right quantity, maintaining soil: air ratio at an optimum level for plant growth and development (Reddy and Aruna, 2009). This situation increased the availability of nutrients in the soil throughout the growing season and only 75 per cent recommended dose of nitrogen was sufficient for the crop growth and development. The longer interval between two irrigations in surface method resulted in greater soil water tension towards the end of the irrigation cycle which lowered the availability of soil water. The less available soil moisture may result in closure of stomata which tend to raise the plant body temperature (Sagarka *et al.,* 2002). This would lead to greater respiration and breakdown of assimilates.

Incidence of pests: Whitefly population increased with an increase in the dose of nitrogen and decreased with increase in the level of drip irrigation (Table 2). Application of 125 per cent recommended dose of nitrogen significantly increased the whitefly population over its recommended dose. Application of N in six equal

Table 1. Effect of fertigation on growth, yield attributes, seed cotton yield and pest incidence in American cotton (pooled data)

Treatments	Plant population/ ha at 60 DAS	Plant height (cm) at 90 DAS	Bolls/ plant	Boll weight (g)	Seed cotton yield (kg/ha)	Seed index (g)	Average number of whitefly/ leaf	Infestation of spotted bollworm (%)
RD (100%) in 4 Splits	16898	136.6	39.2	3.34	2398	8.45	21.80 (4.27)	16.70 (23.56)
RD (100%) in 6 Splits	16966	139.7	41.8	3.48	2573	8.84	22.00 (4.22)	17.20 (23.77)
RD (75%) in 4 Splits	16700	133.1	38.4	3.28	2238	8.01	20.30 (4.03)	15.60 (22.60)
RD (75%) in 6 Splits	16772	134.7	38.9	3.32	2385	8.27	19.80 (3.86)	15.30 (22.32)
RP*	15508	120.0	32.0	3.19	1718	7.53	26.50 (4.67)	19.20 (25.36)
S. Em. ±	174	1.8	1.03	0.06	42	0.09	0.08	0.58
P=0.05	501	5.2	2.96	0.18	120	0.26	0.24	1.66

Figures in parentheses are the under root values (whitefly) and angular transformed values (spotted bollworm).
* Recommended practice of irrigation and fertilizer application

Table 2. Effect of different treatments on growth, yield attributes, yield and pest incidence in *desi* cotton (pooled data of 3 years)

Treatments	Plant population/ ha	Bolls/ plant	Boll weight (g)	Seed cotton yield (kg/ha)	Whitefly/ leaf	Spotted bollworm damage (%)
0.8 ETc	16699	37.03	2.33	2018	7.92 (2.81)	10.95 (19.14)
1.0 ETc	17007	39.60	2.33	2098	6.84 (2.60)	11.98(20.15)
SE.m +	65	0.52	0.07	27	0.02	0.18
P=0.05	NS	1.48	NS	NS	0.05	0.52
Drip	16853	38.40	2.33	2058	7.36(2.70)	11.47(19.64)
RP	14274	39.17	2.29	1683	12.37 (3.50)	13.53(21.52)
SE.m +	160	1.27	0.18	69	0.05	0.45
P=0.05	455	NS	NS	197	0.13	1.27
RN* (75%)	16994	37.86	2.31	2021	6.69 (2.57)	10.58(18.85)
RN (100%)	16927	38.56	2.32	2057	7.03 (2.64)	11.28(19.49)
RN (125%)	16638	38.52	2.37	2096	8.44 (2.90)	12.54(20.59)
SE.m +	80	0.64	0.09	35	0.02	0.22
P=0.05	NS	NS	NS	NS	0.07	0.64
Six splits	16824	38.38	2.31	2066	7.63 (2.75)	11.57(19.75)
Nine splits	16882	38.25	2.35	2050	7.13 (2.65)	11.32(19.54)
SE.m +	65	0.52	0.07	27	0.02	0.18
P=0.05	NS	NS	NS	NS	0.05	NS

Figures in parentheses are the under root values (whitefly) and angular transformed values (spotted bollworm)
* Recommended dose of nitrogen

splits had more infestation of whitefly than nine equal splits. Significantly higher white fly incidence was recorded in recommended practice of irrigation than that of drip irrigation. Increasing the levels of irrigation and nitrogen increased the infestation of the spotted bollworm. The damage of spotted bollworm in conventional method of irrigation was found significantly higher than drip irrigation.

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