Available online at www.sciencedirect.com
ScienceDirect
Soil & Tillage Research 99 (2008) 76–83
Soil & Tillage Research
www.elsevier.com/locate/still

Effects of sowing date, tillage and residue management on productivity of cotton (*Gossypium hirsutum* L.)–wheat (*Triticum aestivum* L.) system in northwest India

S.K. Jalota [a], G.S. Buttar [b], Anil Sood [c,*], G.B.S. Chahal [a], S.S. Ray [d], S. Panigrahy [d]

[a] *Department of Soils, Punjab Agricultural University, Ludhiana, India*
[b] *Punjab Agricultural University Regional Research Station, Bathinda, India*
[c] *Punjab Remote Sensing Centre, Ludhiana, India*
[d] *Space Applications Centre, Ahmedabad, India*

Received 5 February 2007; received in revised form 25 August 2007; accepted 6 January 2008

Abstract

In southwestern region of Punjab in north India, sowing dates of cotton crop in cotton (*Gossypium hirsutum* L.)–wheat (*Triticum aestivum* L.) system are staggered from last week of April to mid of May depending upon the surface water supply from canal as ground water is not fit for irrigation. Further, farmers practice intensive cultivation for seedbed preparation and burning of wheat straw before sowing of cotton crop. With the present farmers' practices, yields have become static and system has become non-profitable. Field experiments were conducted on Entisols for two rotations of cotton–wheat system during the years of 2004–2005 and 2005–2006 in split plot design to study the direct and interactive effects of date of sowing and tillage-plus-wheat residue management practices on growth and yield of cotton and wheat and to increase the profitability by reducing the tillage operations, which costs about 50% of the sowing cost. The pooled analysis showed that in cotton crop, there was a significant interaction between year × dates of sowing. Among different tillage-plus-wheat residue management practices yields were 23–39% higher in tillage treatments than minimum-tillage. In wheat, grain yield in tillage treatments were at par. Water productivity amongst the tillage treatments in cotton was 19–27% less in minimum tillage than others tillage treatments. Similar trend was found in wheat crop. Remunerability of the cotton–wheat system was more with a combination of reduced tillage in cotton and minimum tillage in wheat than conventional tillage.

Keywords: Cotton–wheat; Sowing time; Tillage; Crop residue; Entisols; Punjab

1. Introduction

Cotton–wheat is a dominant cropping system in semi-arid region of southwestern Indian Punjab. It covers 11% of the total cultivated area (4.6 m ha). In this cropping system, sowing of cotton is staggered from end of April to mid of May depending upon the surface water supply from canal as the ground water is not fit for irrigation (Singh et al., 2002). Seedbed for cotton is prepared with tillage operations consisting of two disking, two cultivators and one planking that costs about US$ 70 ha^{-1}, 50% of the total cost for sowing of cotton. The crop residues are not

* Corresponding author. Tel.: +91 161 2303484; fax: +91 161 2303483.
E-mail address: anilsood_prsc@rediffmail.com (A. Sood).

0167-1987/$ – see front matter © 2008 Elsevier B.V. All rights reserved.
doi:10.1016/j.still.2008.01.005

incorporated in the field. The sticks of cotton are pulled out, removed from the field and used as fuel. In wheat crop following cotton, the same tillage operations as in cotton are repeated, but the straw of wheat is either removed from the fields or is burnt due to shortage of time between harvesting of wheat crop (mid April) and sowing of cotton crop (end of April to mid of May) that causes loss of carbon and other nutrients (Beri et al., 2003) and development of water repellency in soil (Singh et al., 2005). As a result, productivity of cotton–wheat system has become static or started declining and is showing the sign of fatigue. In the year 2001, area under cotton crop was reduced to 0.407 m ha from 0.71 m ha in 1991 (Statistical Abstract, 2005). The declining soil fertility, especially soil-organic matter, is one of the important factors responsible for this decline (Olk et al., 1996). Hence there is emphasis on building up soil organic matter and to improve organic matter in soil, organic and green manures and crop residues are commonly advocated. But in the era of intensive agriculture and demands of galloping population, the chances of leaving the soil fallow for green manuring is very little and the available practical option left only is the crop residue management. Therefore, it is envisaged that an economical tillage-plus-crop residue management practices should be devised to increase the profitability by reducing the cost of tillage. Keeping this in view, field experiments were conducted for 2 years with the objectives to (1) study the effects of date of sowing, tillage-plus-wheat residue management practices on the growth and yield of seed cotton and subsequent wheat. (2) Explore possibility of increasing profit by reducing the tillage operations.

2. Methods and materials

2.1. Site characteristics

Field experiments were conducted for two rotations of cotton–wheat system in years of 2004–2005 and 2005–2006 on Entisols, low in organic carbon (0.21%) and nitrogen (41 kg ha^{-1}), medium in available phosphorus (13.9 kg ha^{-1}) and high in potassium (431 kg ha^{-1}) at PAU Regional Research Station, Bathinda (30°58″ latitude, 74°18″ longitude and 211 m above mean sea level). Soil physical (texture, bulk density and hydraulic conductivity) and chemical (pH, EC, OC, ammonical nitrogen and nitrate nitrogen) properties of experimental field were determined up to 1.8 m with 0.15 m soil depth interval. The sand, silt and clay contents were determined by the International Pipette Method, bulk density with core method, hydraulic conductivity with constant head method (Jalota et al., 1998). EC was measured with solu bridge method (Chopra and Kanwar, 1976) and pH with potentiometric method (Jackson, 1973), OC by wet digestion method (Walkley and Black, 1934). Ammonical and nitrate nitrogen were determined by KCl method (Keeney, 1982). Physical properties of the soil profile showed that below 90 cm there is sharp increase in bulk density and decrease in hydraulic conductivity in soil layers (Table 1). The soil texture was loamy sand to sand for 0–45 cm of soil depth and thereafter texture changed to silt up to 180 cm of soil depth in the soil profile. The ground water at the experimental site was more than 10 m deep. The cumulative pan evaporation (Pan-E) and rainfall for 2 years of experimentation during cotton and wheat crops were recoded at meteorological laboratory situated at the experiment site and is presented in Figs. 1 and 2, respectively.

2.2. Treatments

Treatments in cotton comprised combination of 2 dates of sowing and 5 tillage-plus-residue management practices that are given below. Dates of sowing were kept in main plot and tillage cum residue treatments in the subplots with 6 replications.

- Main: two dates of sowing.
- 25–26 April (D_1) and 17–18 May (D_2).
- Sub: five tillage-plus-residue management.
- CTSB: conventional tillage (2 disking + 2 cultivator + 1 planking) + wheat straw[1] burnt.
- CTSI: conventional tillage (2 disking + 2 cultivator + 1 planking) + wheat straw incorporated.
- RTSI: reduced tillage (1 disking + 1 cultivator + 1 planking) + wheat straw incorporated.
- MTSAS: minimum tillage (no disking and no cultivator) + wheat straw on the soil surface as such.
- CTSR: conventional tillage (2 disking + 2 cultivator + 1 planking) + wheat straw removed from the field.

[1] The amount of wheat straw burnt, incorporated in conventional and reduced tillage and kept as such in minimum tillage was 2.5 t ha^{-1}. The depth of tillage was 0.15 m. The wheat straw comprised of 0.37, 0.51, 0.14, 0.88, 0.13, 0.23, 0.11 and 0.09% C, N, P, K, S, Ca, Mg and Na, respectively (Beri et al., 2003).