Field Crops Research 215 (2018) 59–65

Contents lists available at ScienceDirect

Field Crops Research

journal homepage: www.elsevier.com/locate/fcr

Mepiquat chloride effects on cotton yield and biomass accumulation under late sowing and high density

Shahbaz Atta Tung, Ying Huang, Abdul Hafeez, Saif Ali, Aziz Khan, Biangkham Souliyanonh, Xinghu Song, Anda Liu, Guozheng Yang*

MOA Key Laboratory of Crop Eco-Physiology and Farming System in the Middle Reaches of the Yangtze River, Huazhong Agricultural University, Wuhan, 430070, PR China

ARTICLE INFO

Keywords:
Cotton
Mepiquat chloride
Growth
Biomass accumulation
Yield attributes

ABSTRACT

Cotton production is challenged by high cost with multiple management and material inputs including mepiquat chloride (MC) application to avoid excess vegetative growth and yield losses. A competitive planting model has been practiced in recent years in Yangtze River Valley, China characterized with late sowing, high density and low fertilization. We hypothesized that MC could also be ignored under this planting model to cut down the cost further. A 2-year field experiment was performed to determine cotton response to MC in allied growth and yield dynamics in 2015 and 2016. MC was applied thrice with 5 leaf intervals initiated from the 6th leaf stage in 5 different dosages i.e. 0 (control), 30, 60, 90, and 120 g ha^{-1}. The results showed that the lint yield was reduced by 6–29% with increase in MC dosages resulted from the reduced cotton plants biomass (from 1036 gm^{-2} of MC0 to 841 gm^{-2} of MC120) especially the reproductive organs biomass (492 gm^{-2} of MC0 to 376 gm^{-2} of MC120) averaged across two years. The biomass accumulation for control (MC0) during the fast accumulation period (FAP) had a higher rate (10.1 and 29.8 gm^{-2} d^{-1} in 2015 and 2016, respectively) for plant biomass and a longer period (34.5 and 28.0 d in 2015 and 2016, respectively) for reproductive organs biomass. The results suggested that MC application could be omitted in the new cotton planting model, ensuring more economic benefits by waiving off the labor and chemicals cost involved.

1. Introduction

Cotton is the most significant fiber and commercial crop globally. It is grown as an annual crop specifically for lint, oil seed, and meal for animals (Constable and Bange, 2015). Cotton fiber has multiple uses in our daily life because of its excellent adaptation and great production particularly in China. Worldwide, cotton is cultivated in more than 70 countries occupying 32 million hectares of land. China was the leading cotton producer with 1438 kg/ha lint yield during 2013 followed by US, India and Pakistan (USDA, 2013). Sufficient supply of fertilizer and irrigation sometime results in extensive vegetative growth that would probably be highly susceptible to disease and harvest losses, ultimately resulting in lower yields (Cathey and Meredith, 1988). Owing to the rampant vegetative growth of cotton, a lot of labor is required for topping and thinning. The plant growth retardants have been reported to enhance cotton productivity by transforming canopy structure, adjusting plant's hormonal balance and improved source-sink ratio (Siebert and Stewart, 2006; Rosolem et al., 2013).

Mepiquat chloride (MC), is a growth regulator (*N,N*-dimethylpiperidinium chloride) that has been used globally to control plant geometry as it can be absorbed by the leaves and distributed throughout the plant (Rosolem et al., 2013), and it has been used to manage the vegetative growth in cotton crop (Kerby, 1985). MC mediated morphological alterations in terms of canopy development, source sink relationship, photo-assimilates partitioning and light interception, the pivotal factors of cotton lint yield. MC is mainly used to maintain the balance of vegetative and reproductive growth that in turns regulates cotton yield (Zhao and Oosterhuis, 2000; Yang et al., 2014). Its application inhibits endogenous gibberellic acid biosynthesis that results in compact structured and short statured plants by inhibiting cell elongation and reducing length of the internodes (Rademacher, 2000). Moreover, MC application induces the reduction of leaf expansion, stem, petiole length, number of nodes as well as enhanced maturity of cotton crop with variable yield responses (Cook and Kennedy, 2000; Bogiani and Rosolem, 2009; Mao et al., 2015).

Hubei is one of the major cotton growing regions in China (Yang

Abbreviation: MC, Mepiquat chloride; FAP, fast accumulation period; VT, average speed; VM, maximum speed; t1, t2 beginning and terminating days of the fast accumulation period; CPB, cotton plant biomass; VPB, vegetative parts biomass; RRB, reproductive relative parts biomass; RPB, reproductive parts biomass; d, days; DAE, days after emergence

* Corresponding author.
E-mail address: ygzh9999@mail.hzau.edu.cn (G. Yang).

http://dx.doi.org/10.1016/j.fcr.2017.09.032
Received 25 August 2017; Received in revised form 22 September 2017; Accepted 25 September 2017
Available online 06 November 2017
0378-4290/

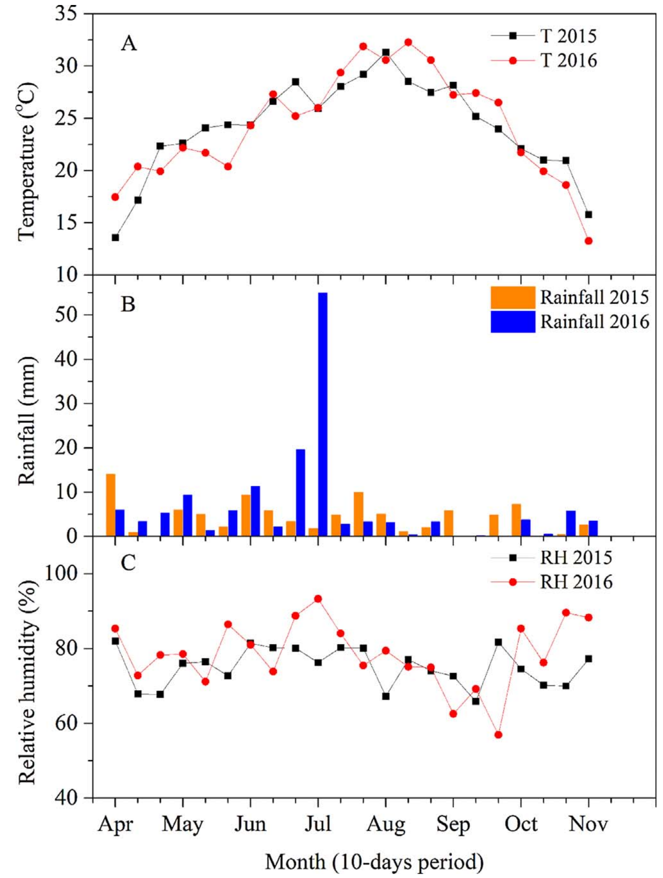

Fig. 1. Monthly weather summary during the cotton growing season in 2015 and 2016 at Wuhan, China. T shows temperature and RH shows relative humidity.

Table 1
Timing and dosage (g ha^{-1}) of MC application in cotton.

Treatment	6 leaf stage	11 leaf stage	16 leaf stage	Total dose
MC0	0	0	0	0
MC30	6	9	15	30
MC60	12	18	30	60
MC90	18	27	45	90
MC120	24	36	60	120

and Zhou, 2010), contributing 12.3% of the total national lint yield production. Cotton-rapeseed or cotton-wheat cropping systems have been widely practiced in two cotton inland planting regions (Yellow River Valley and Yangtze River Valley) of China. In this cropping system, cotton seedlings are transplanted after rapeseed harvesting or in the space preserved between the rows of wheat plants harvesting. Cotton planting in this region is a laborious practice due to raised bed sowing and transplantation in the field (Lu et al., 2017). This in turn worsens the situation due to an ever increasing migration of farm labor towards cities since 1990. Therefore, Cotton production in recent years has become more costly due to high cost of labor force and multiple measures, including MC application to ensure a good yield (Yang and Zhou, 2010). To ensure the sustainable development of cotton production, researchers pursued a new profitable planting model by cutting down the cost without compromising yield which is characterized with late and direct sowing, high density, and low fertilization.

Yang et al. (2011) obtained similar cotton yield under this new planting model where cotton seeds were directly sown in mid-May with lower N rate of 225 kg/ha and higher density of 6 plants m^{-2}, due to a quicker and stronger accumulation of biomass (especially the reproductive parts) during the flowering and boll setting period. Furthermore, one-time fertilization at first bloom can be a possible cost-effective alternative for cotton production as compared to conventional fertilization with three splits i.e. preplant, first bloom, peak bloom, in Yangtze River Valley of china (Yang et al., 2012). N rate could be further lowered to be 180 kg N ha^{-1} with 9 plants m^{-2} of planting density (Khan et al., 2017a,b) or even 120 kg/ha with 10 plants m^{-2} of planting density to get the similar harvest (Shah et al., 2017) with one-time fertilization. The reasons for the similar cotton harvest in the shorter growing season were due to more K uptake (Khan et al., 2017a), more N acquisition (Khan et al., 2017b), and stronger leaf gas exchange (Shah et al., 2017). Since high density planting by using ultra-narrow rows (UNR) strategy helps in earliness and provided high yield as compared to conventional production system (Shah et al., 2017).

Under the new production model, the cotton growing season is shortened. Therefore, it is hypothesized that MC application under traditional cultivation system could be ignored to cut down the cost further. In this work MC effect on cotton crop phenology, dry matter production and yield dynamics under new cotton planting model were determined to prove the hypothesis that its application can be omitted without compromising yield attributes.

Table 2
Response of cotton growth stages and period under mepiquat chloride applications during the year 2015 and 2016.

Treatment	Growing stages/m-d				Growing period/(d)			
	Emergence	Squaring	Bloom	Opening	Seedling	Squaring	Boll setting	Total
2015								
MC0	5.26	7.11	8.02	9.16	46a*	22a	45 b	113 a
MC30	5.26	7.11	7.30	9.16	46a	19a	48 a	113 a
MC60	5.26	7.11	7.31	9.15	46a	20a	47 ab	112 a
MC90	5.26	7.13	8.03	9.15	48a	21a	44 b	112 a
MC120	5.26	7.13	8.03	9.19	48a	21a	48 a	116 a
2016								
MC0	5.29	7.28	8.30	10.11	60a	18a	57a	135a
MC30	5.29	7.28	8.30	10.10	60a	18a	56a	134a
MC60	5.29	7.27	8.30	10.12	59a	19a	58a	136a
MC90	5.29	7.27	8.30	10.11	59a	19a	57a	135a
MC120	5.29	7.27	8.30	10.11	59a	19a	57a	135a

In Table m-d shows month-date; (d) days.

* Values followed by a different letter within the same column are significantly different at ($P < 0.05$) probability level according to Least Significant Difference (LSD) test.