Effects of Nitrogen and Potassium Application on Plant Growth, Yield and Fiber Quality of Cotton(*Gossypium hirsutum L.*)

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INTRODUCTION

Cotton (*Gossypium hirsutum* L.)

- major cash crop grown primarily for fiber and oil seed in the world

(Oosterhuis 2001)

- one of the most important industrial crops and essential for local consumption and export for foreign exchange

(Pye Tin 2003)

- In Myanmar, grown – pre-monsoon, monsoon & post-monsoon seasons
- Western Bago, Mandalay, Magway & Sagaing

(ICAC 2008)

- Unique - perennial with an indeterminate growth habit

(Oosterhuis 2001)

- Nutritional needs - more complex than any other field crops

(Grimes and El-Zik 1990)

- Major factor - both yield and quality - adequate and balanced nutrition

- Balanced fertility - essential - optimizing yields, increasing profits, and improving efficiency of fertilizer application **(Johnson et al. 1997)**

Nitrogen (N)

- Essential macronutrient
- Building block for proteins & chlorophyll synthesis

(Hou et al. 2007)

N can be lost from the system in several ways - considered - N management plan

- N fertilization had significant impacts on plant growth, lint yields and fiber quality

(Bonada et al. 1996)

Deficiency and Excess of Nitrogen (N)

Deficiency	Excess
1 Decreased boll production, poor plant development (Zhang et al. 2011)	**1** Excessive vegetative growth, delay maturity (Hodges 2002)
2 Reduced plant height, fruiting branches & increased boll shed (Hodges 1995)	**2** Increased pest & disease, reduced lint yield & fiber quality (Main et al. 2010)

- Important nutrients for cotton - difficult to manage
- N nutrition - most important factor in cotton production

(Bondada and Oosterhuis 2001)

Potassium (K)

Vital role in growth & metabolism

(Read et al. 2006)

Activating number of important enzymes

(Evans & Sorger 1966)

Cotton required K to activate response of N

(Pye Tin 1995)

Important role during fiber development

(Oosterhuis 2001)

Major solute in the fiber for fiber elongation

(Dhinsa et al. 1975)





Normal leaf

•K application with other nutrients – more tolerant to pests & diseases **(Perrennoud 1990)**

•Sensitivity - K supply, large requirement for K & immobility in soil, lead deficiency even on soils - high in extractable K **(Oosterhuis, 1995)**

K deficient leaf

1998)

Objectives

1. To investigate the effects of different rates of N and K fertilizer on the growth and yield component of cotton

2. To examine the effects of different rates of N and K fertilizer on the fiber quality of cotton and

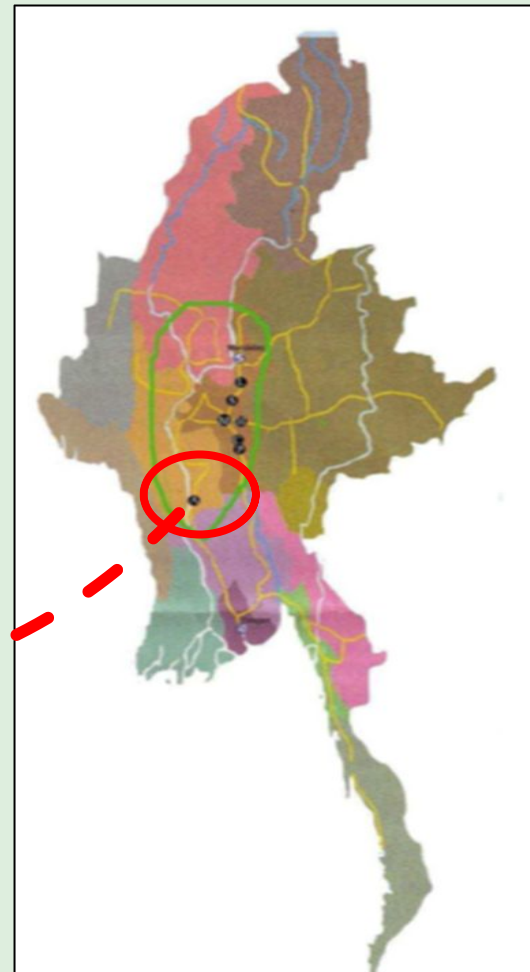
3. To evaluate the interaction of N and K nutrition on seed cotton yields




Materials & Methods

Experimental sites

- Two-seasons field experiment
- Cotton Seed Farm Pyawbwe, Mandalay Region
- Pre- and post-monsoon seasons (2015-16)



Design	Two factors factorial RCB with 3 replications	
Tested cultivar	Ngwe chi - 9	
Spacing	0.75 m x 0.75 m	
Plot size	6.8 x 5.3 m^2	
No. of rows plot $^{-1}$	7 rows (9 hills row $^{-1}$)	
Whole experimental size	60 m x 32 m	

Treatments

Factor (A)
Nitrogen application

N_0 - without Nitrogen

N_1 - 60 kg N ha^{-1}

N_2 - 120 kg N ha^{-1}

N_3 - 180 kg N ha^{-1}

Factor (B)
Potassium application

K_0 - without Potassium

K_1 - 62.25 kg K ha^{-1}

K_2 - 124.50 kg K ha^{-1}

Fertilizer application

- Equally three split application of N and K fertilizer for all treatments
- All plots were provided a basal application of phosphorous 26.4 kg P ha^{-1}

Before sowing

Squaring stage

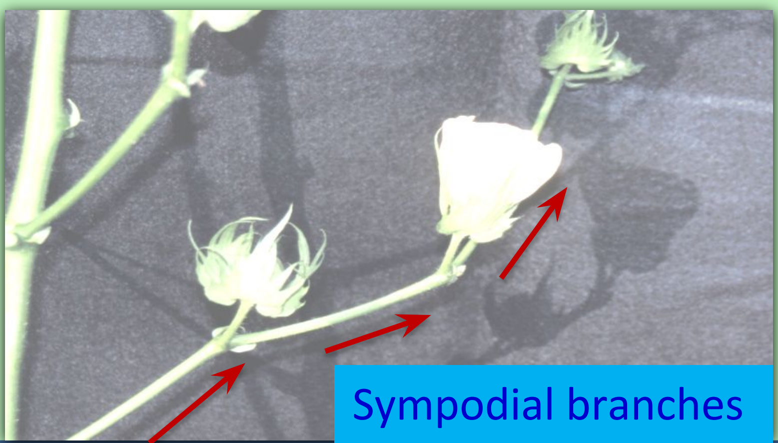
Flowering stage

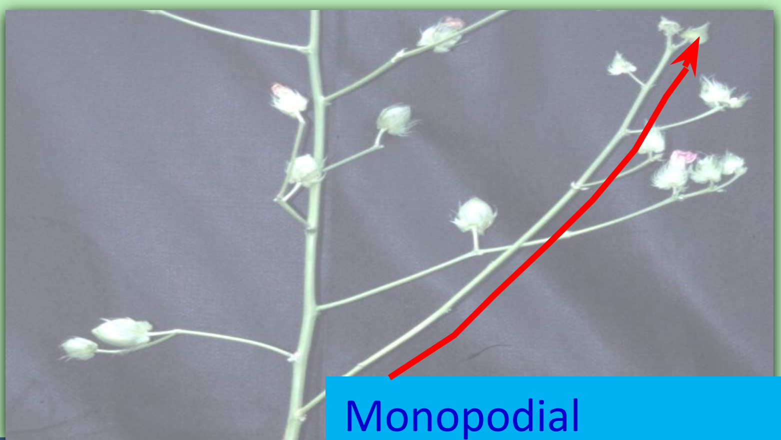
Data collections

(1) Plant sampling

(a) Growth characters

- Plant height (cm)
- Number of main-stem nodes plant^{-1}
- Number of sympodial branches plant^{-1}
- Number of monopodial branches plant^{-1}





(b)Yield and yield components

- Number of squares plant^{-1}
- Number of flowers plant^{-1}
- Number of boll plant^{-1}
- Boll weight (g)
- Thousand seed weight(g)
- Boll weight plant^{-1} (g)

For both seasons, ten sampled plants were randomly selected from the sampling areas to observe the above characters

(2) Fiber quality

- Fiber length (mm)
- Fiber strength (lb mg^{-1})
- Fiber fineness (micronaire)
- Fiber maturity ratio
- Ginning percent (%)

In both seasons, ten open bolls - picked & analyzed for fiber quality

Fiber quality test – carried out at Cotton fiber and Yarn Testing Laboratory, Meiktila Township

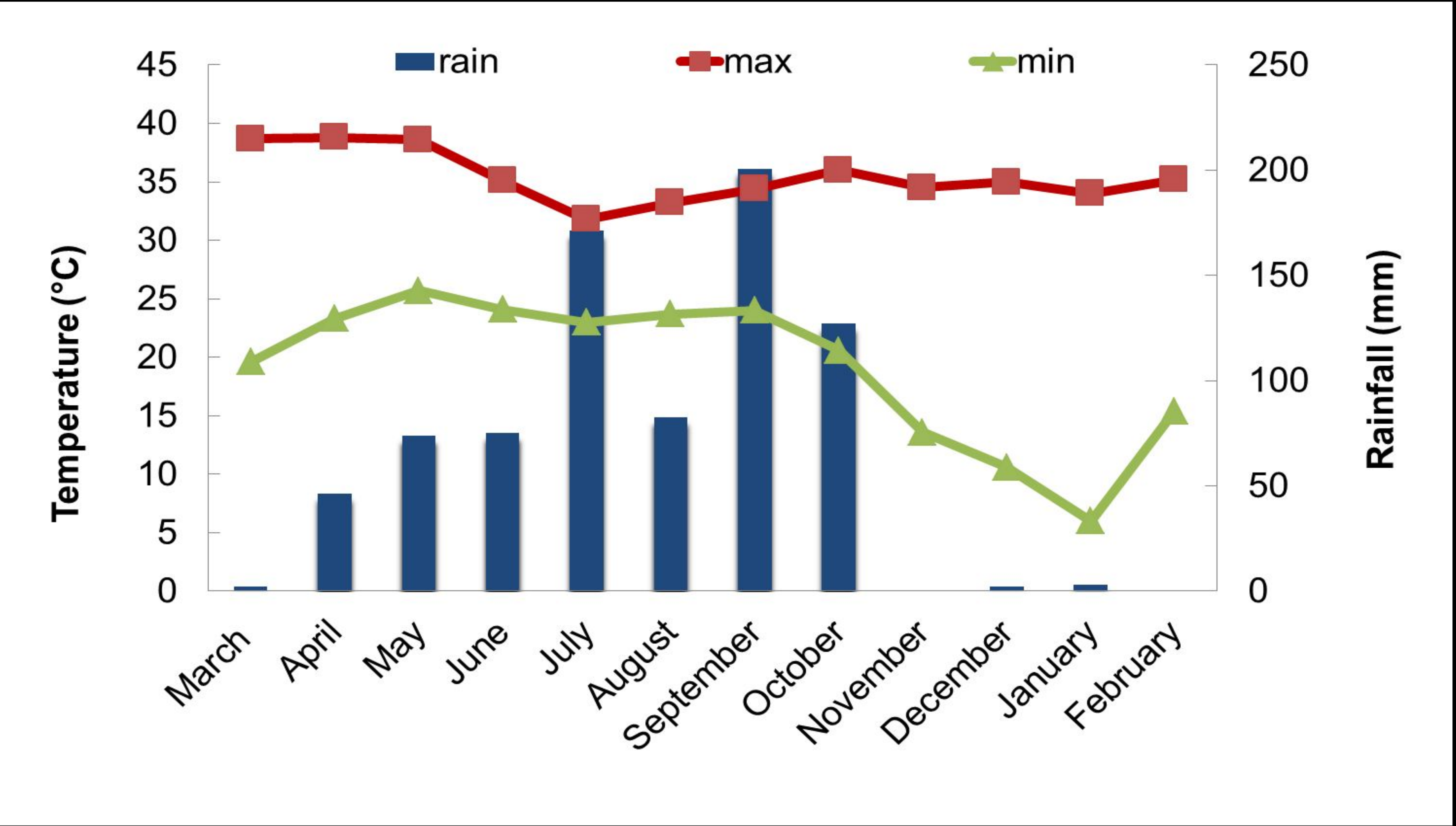


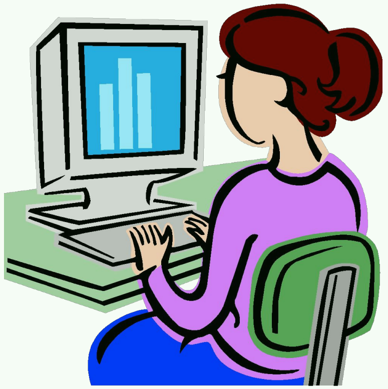
Figure 1. Monthly means rainfall, minimum and maximum temperature during experimental period (March 2015 – January 2016)

Table 1. Measurement of physicochemical properties of experimental soil

Parameters		Amount (rating)
Soil Texture	-	Silt loam
Texture% (sand, silt, clay)	-	(20.8%,52.3%,26.9%)
Soil pH	-	6.8 (neutral)
Available N (mg kg^{-1})	-	76 (medium)
Available P (mg kg^{-1})	-	19 (medium)
Available K (mg kg^{-1})	-	343 (high)
Bulk density (g cm^{-3})	-	1.3
Cation Exchange capacity ($cmol_{(+)}$ kg^{-1})	-	24 (medium)
Organic matter(%)	-	1.6 (low)
EC (dS m^{-1})	-	0.14 (non saline)
Exchangeable Ca ($cmol_{(+)}$ kg^{-1})	-	12 (high)
Exchangeable Mg ($cmol_{(+)}$ kg^{-1})	-	9 (high)
SAR	-	0.58

Statistical analysis

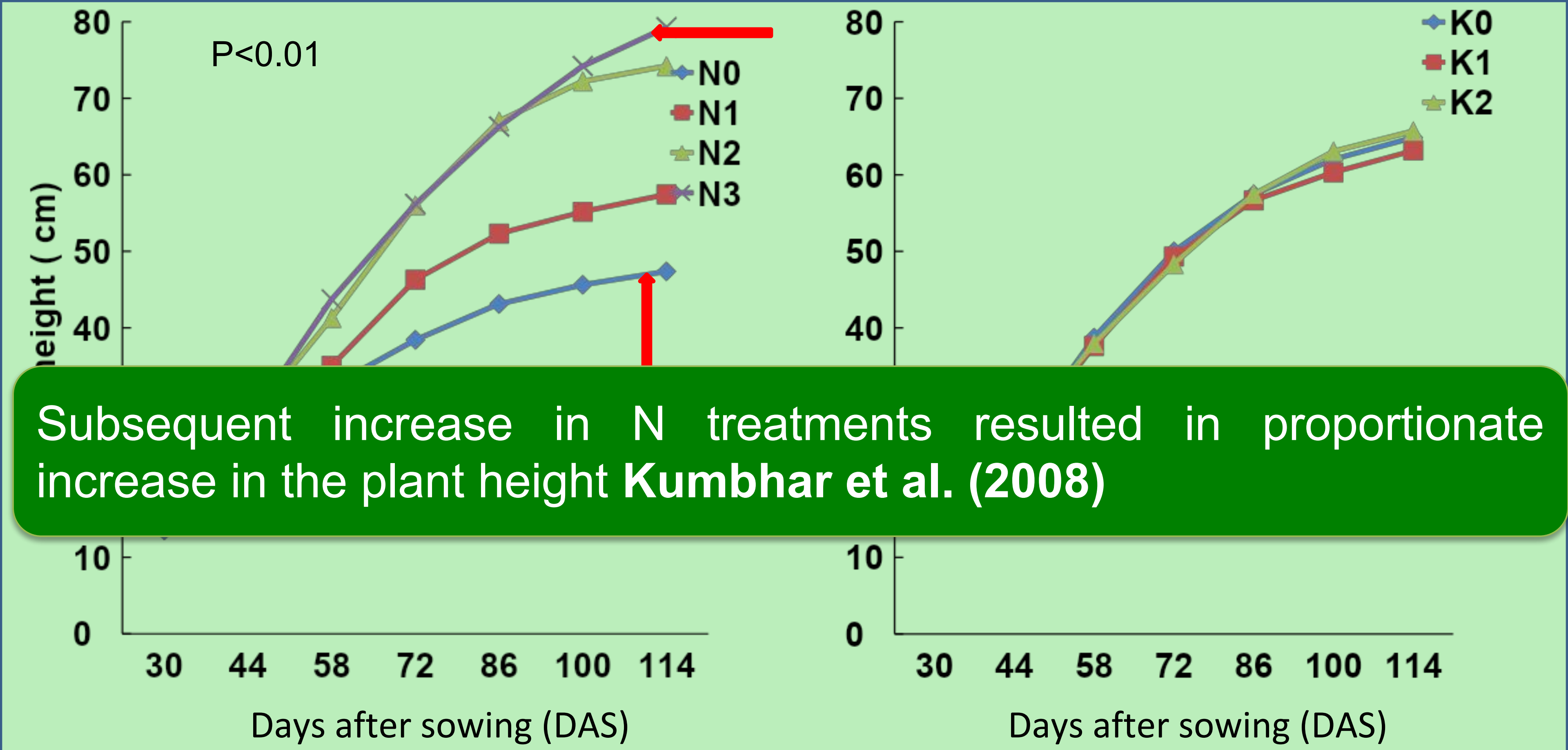
- Statistical analysis was done by using Statistix 8 software
- Treatment means were compared by Least Significant Difference (LSD) test at 5% level



Results & Discussion

For pre-monsoon season

March - August (2015)



Subsequent increase in N treatments resulted in proportionate increase in the plant height **Kumbhar et al. (2008)**

(a) Nitrogen treatments **(b) Potassium treatments**

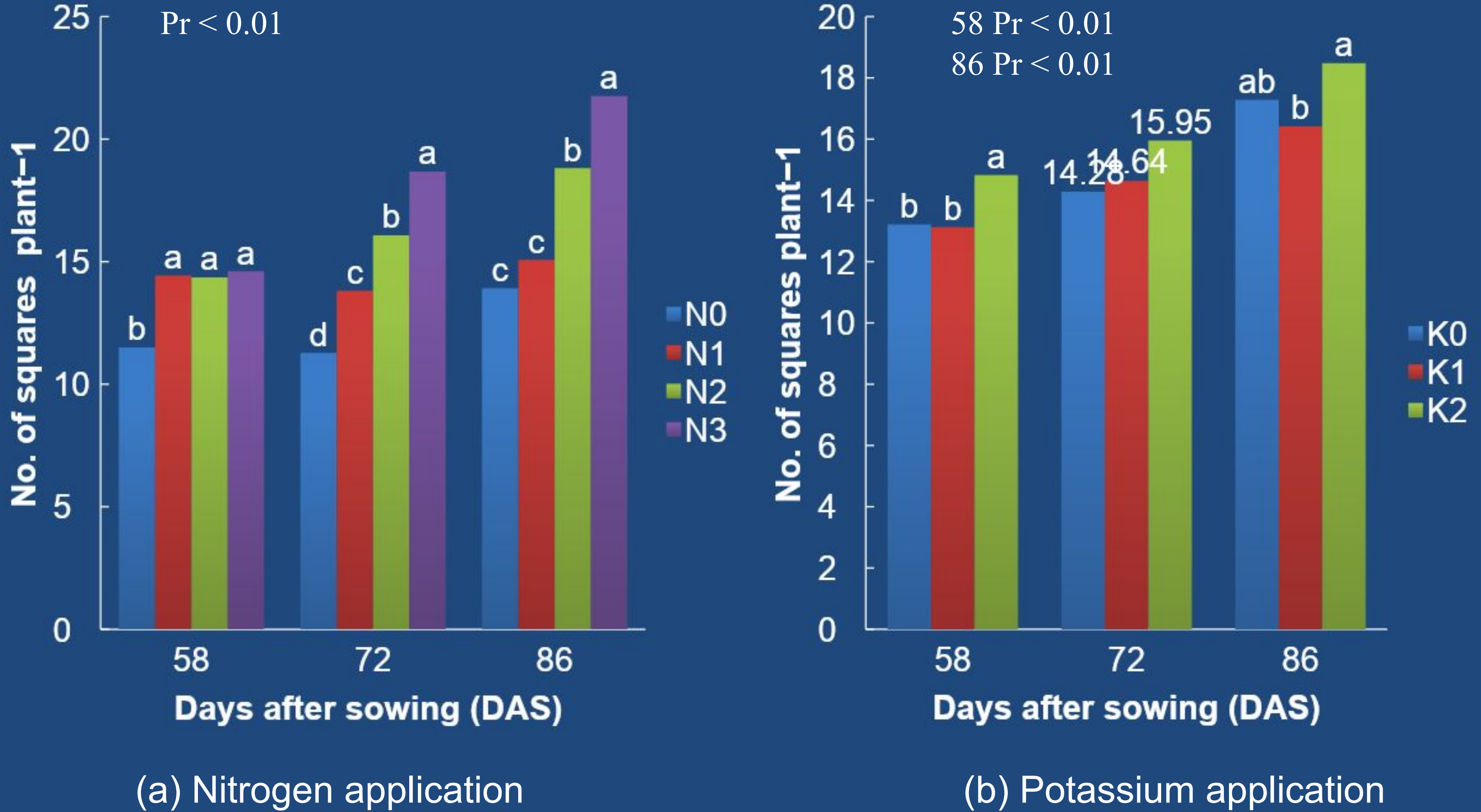
Figure 2. Plant height of cotton as affected by nitrogen and potassium applications in pre-monsoon season, 2015-2016

Table 2. Mean comparison of plant growth characters of seed-cotton as affected by nitrogen and potassium application (pre-monsoon season, 2015)

Treatments	No. of main-stem nodes plant^{-1}	No.of sympodial branches plant^{-1}	No. of monopodial branches plant^{-1}
Nitrogen (N)			
0 kg ha^{-1}	20.60c	12.48b	0.90c
60 kg ha^{-1}	22.46b	13.73a	1.13b
Potassium (K)			
0 kg ha^{-1}	21.87	13.05b	1.26a
62.25 kg ha^{-1}	22.30	13.28b	1.13b
124.5 kg ha^{-1}	23.08	14.23a	1.11b
$LSD_{0.05}$	1.13	0.80	0.12
Pr>F			
N	**	**	**
K	ns	*	*
N × K	ns	ns	ns
CV%	5.95	7.01	12.24

Main stem nodes plant^{-1} was significantly increased with higher N treatments

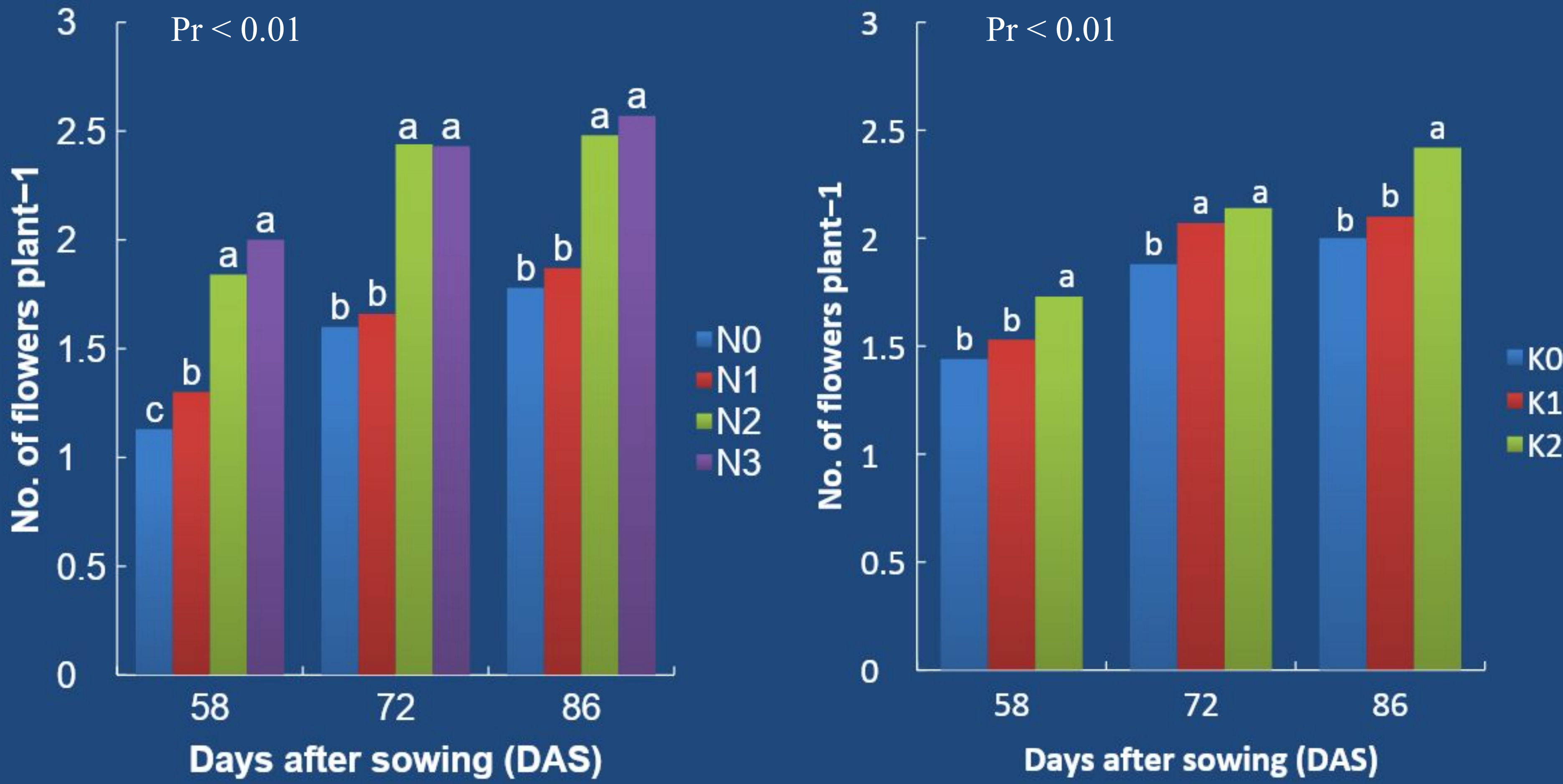
Clawson et al. (2006)



(a) Nitrogen application

(b) Potassium application

Figure 3. Mean values of no. of squares plant $^{-1}$ as affected by nitrogen and potassium application in pre-monsoon season, 2015-2016



(a) Nitrogen application (b) Potassium application

Figure 4. Mean values of no. of flowers plant $^{-1}$ as affected by nitrogen and potassium application in pre-monsoon season, 2015-2016

Table 3. Yield and yield components as affected by N and K application (pre-monsoon season, 2015)

Yield in … t al. 1988)

K fertilization increased seed cotton yield **Pettigrew (2003)**

Treatments	No. of bolls plant^{-1}	Boll wt (g)	1000 seed wt (g)	Boll wt plant^{-1} (g)	Yield (kg ha^{-1})
Nitrogen (N)					
120 kg ha^{-1}	12.57b	3.66a	91.33ab	41.25b	1242.10b
180 kg ha^{-1}	14.72a	3.74a	94.22a	49.43a	1468.30a
$LSD_{0.05}$	0.86	0.13	5.01	3.88	161.64
Potassium (K)					
0 kg ha^{-1}	10.32b	3.51b	89.50	32.31b	900.40b
62.25 kg ha^{-1}	10.96b	3.52b	88.67	34.67b	990.00b
124.5 kg ha^{-1}	13.54a	3.63a	91.00	44.54a	1413.40a
$LSD_{0.05}$	0.75	0.11	4.34	3.36	139.99
Pr>F					
N	**	**	*	**	**
K	**	*	ns	**	**
N × K	**	ns	ns	**	*
CV%	7.61	3.63	5.71	10.69	15.01

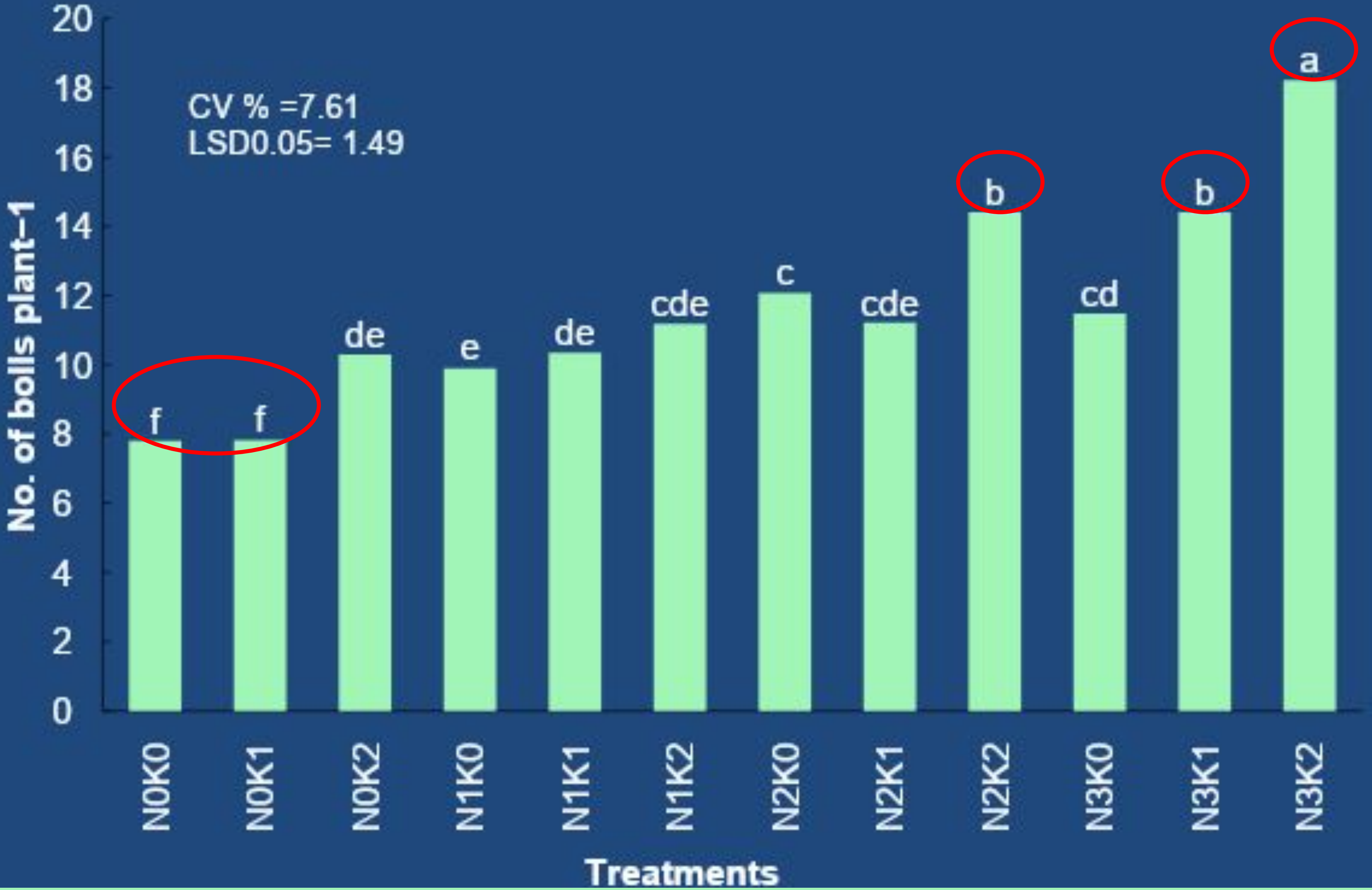


Figure 5. Combination effect of boll plant^{-1} as affected by N and K application in pre-monsoon season, 2015

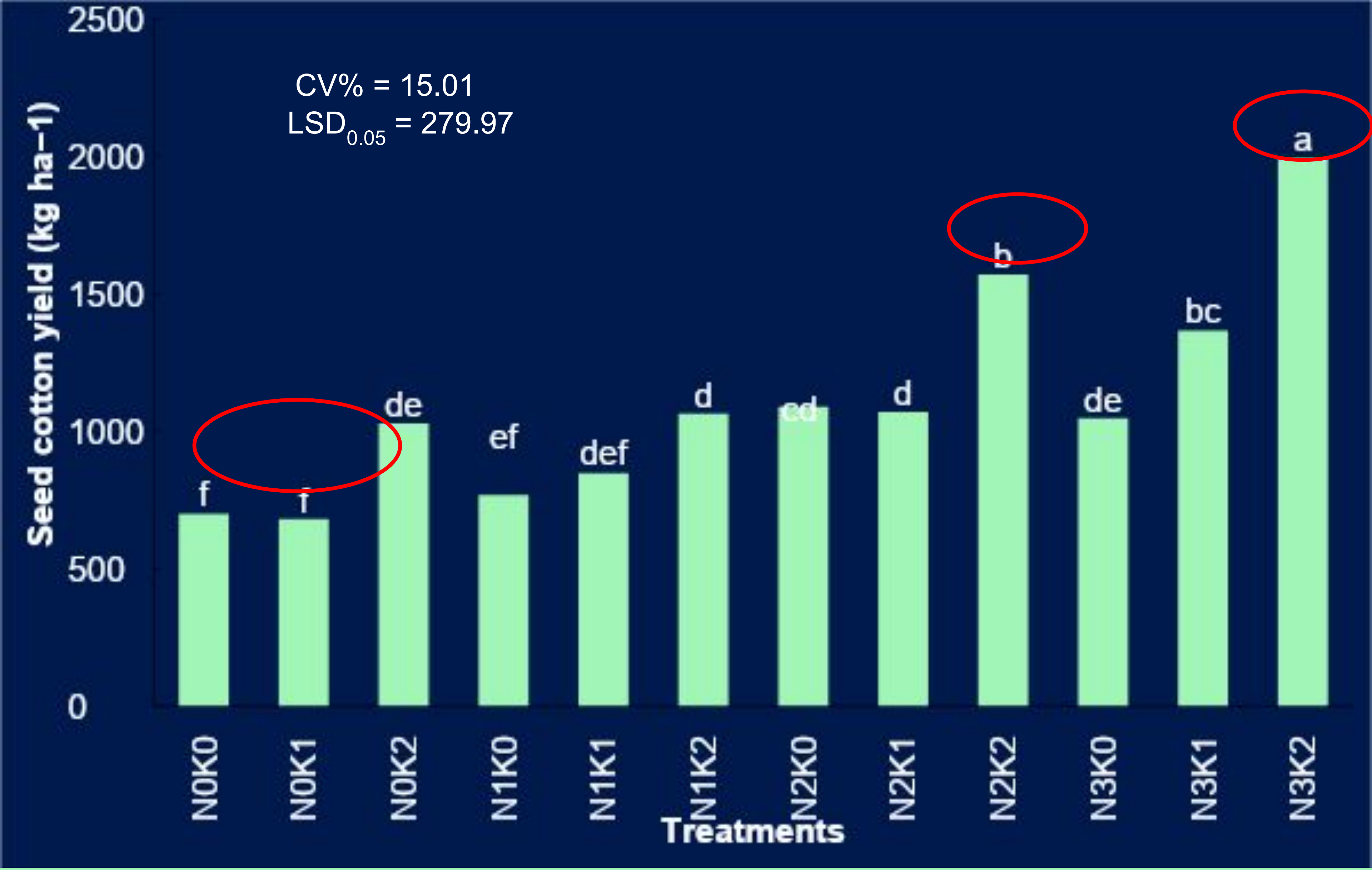


Figure 6. Combination effect of seed cotton yield (kg ha^{-1}) as affected by N and K application in pre-monsoon season, 2015

Table 4. Effect of nitrogen and potassium application on fiber quality of cotton during pre-monsoon season 2015

(Pettigrew 1999) observed that fiber maturity can be reduced when K levels are insufficient.

Treatments	Fiber length (mm)	Fiber strength (lb mg^{-1})	Fiber fineness (micronair)	Maturity ratio	Ginning %
Nitrogen (N)					
180 kg ha^{-1}	28.89	7.96	4.44	0.86	33.71
$LSD_{0.05}$	0.60	0.13	0.32	0.03	1.15
Potassium (K)					
0 kg ha^{-1}	28.25	7.91	4.50	0.86b	33.97
62.25 kg ha^{-1}	28.58	7.96	4.52	0.87ab	33.94
124.5 kg ha^{-1}	28.75	8.01	4.45	0.89a	33.74
$LSD_{0.05}$	0.52	0.11	0.27	0.03	0.99
Pr>F					
N	ns	ns	ns	ns	ns
K	ns	ns	ns	*	ns
N × K	ns	ns	ns	ns	ns
CV%	2.15	1.67	7.2	3.22	3.47



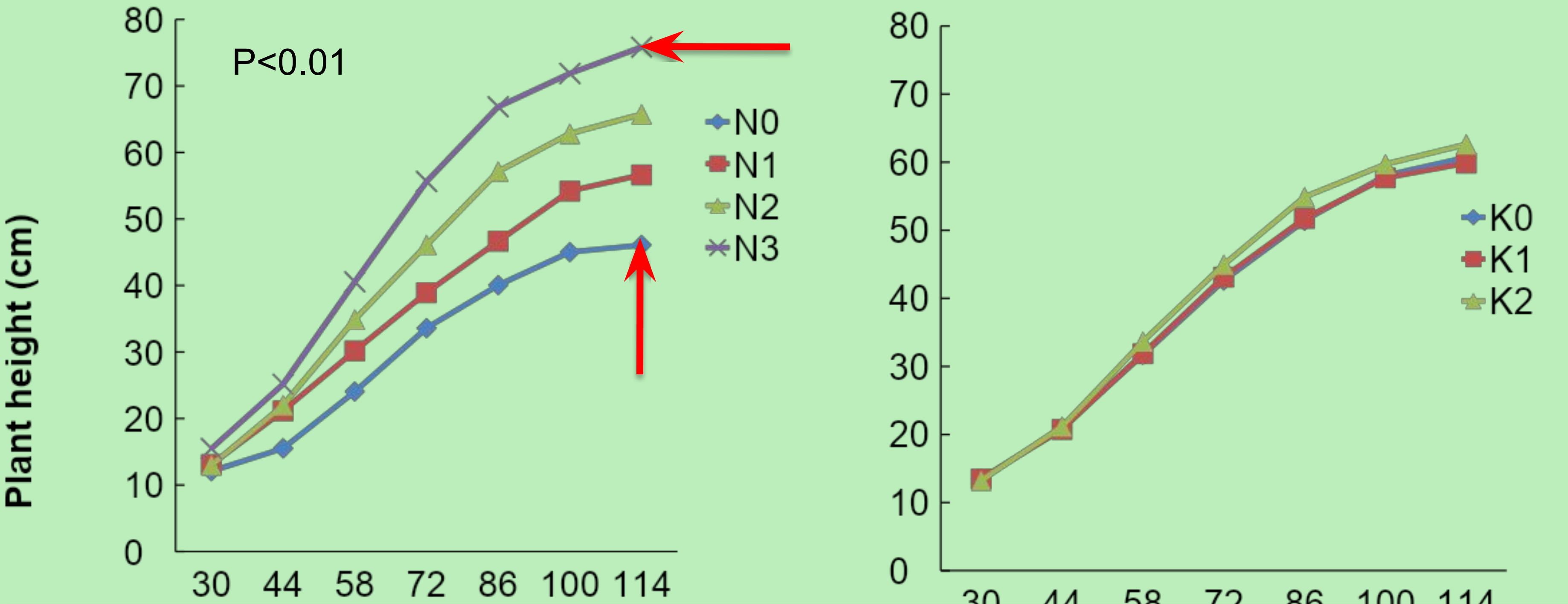
Results & Discussion

For post-monsoon season

August (2015) – January (2016)







Application of highest N fertilizer treatment produced the tallest plants than other
Alitabar et al. (2013)

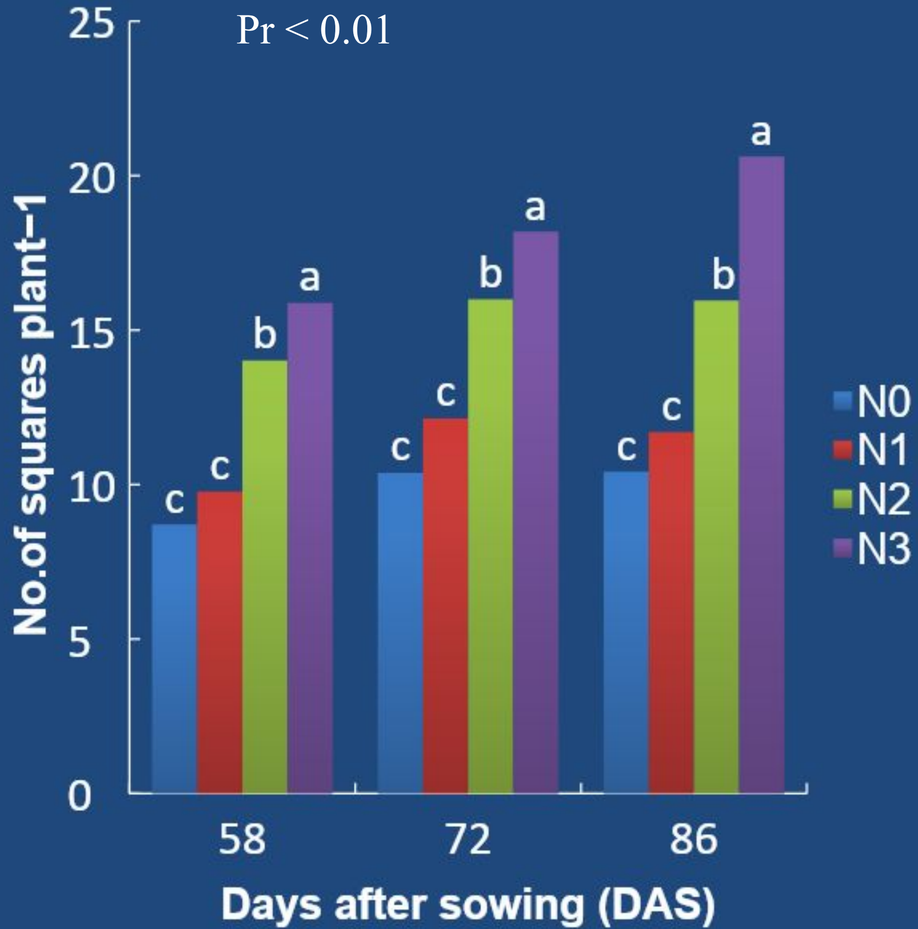
(a) Nitrogen treatments **(b) Potassium treatments**

Figure 7. Plant height of cotton as affected by nitrogen and potassium applications in post-monsoon season, 2015-2016

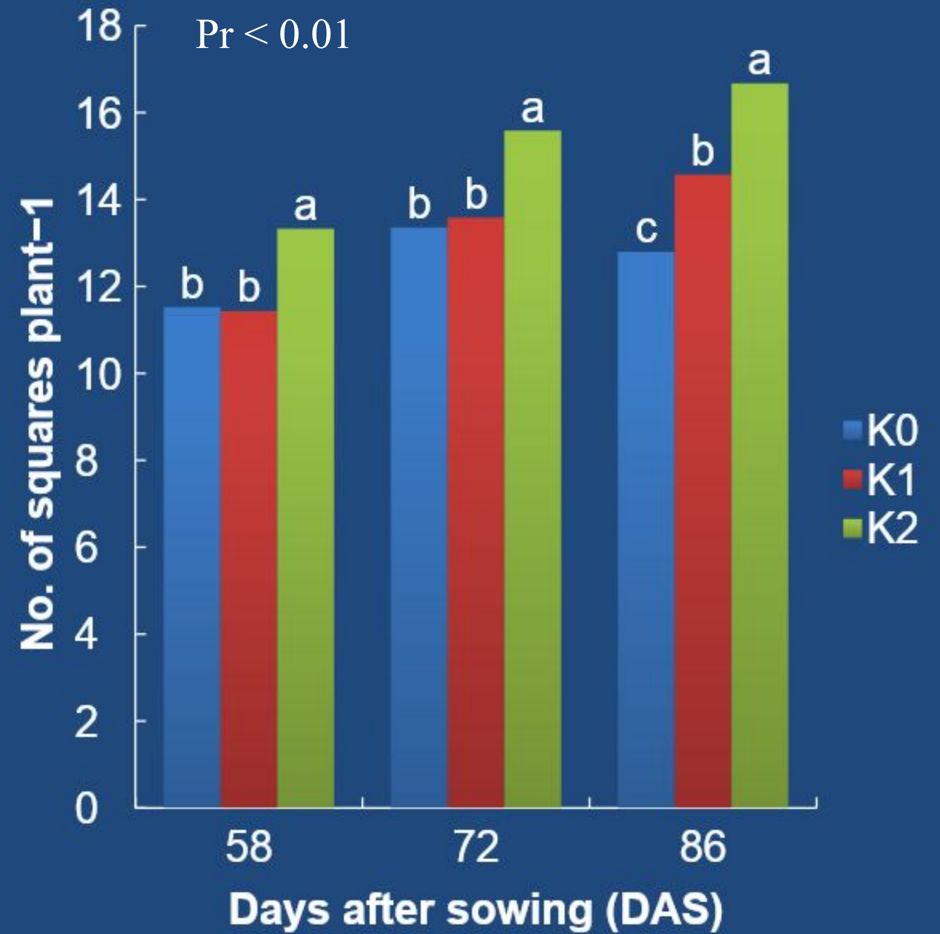
Table 5. Mean comparison of plant growth characters of seed-cotton as affected by nitrogen and potassium application (post-monsoon season, 2015-2016)

Treatments	No. of main-stem nodes plant^{-1}	No. of sympodial branches plant^{-1}	No. of monopodial branches plant^{-1}
Nitrogen (N)			
180 kg ha^{-1}	25.80a	15.73a	1.27a
$LSD_{0.05}$	1.34	1.15	0.16
Potassium (K)			
0 kg ha^{-1}	23.64	13.76b	1.17
62.25 kg ha^{-1}	24.13	14.4ab	1.08
124.5 kg ha^{-1}	24.94	15.17a	1.06
$LSD_{0.05}$	1.16	0.99	0.14
Pr>F			
N	**	**	**
K	ns	*	ns
N × K	ns	ns	ns
CV%	5.66	8.18	14.55

Increased number of sympodial branches plant^{-1} was obtained from Increasing N treatment **Emara & El-Gammaal (2012)**

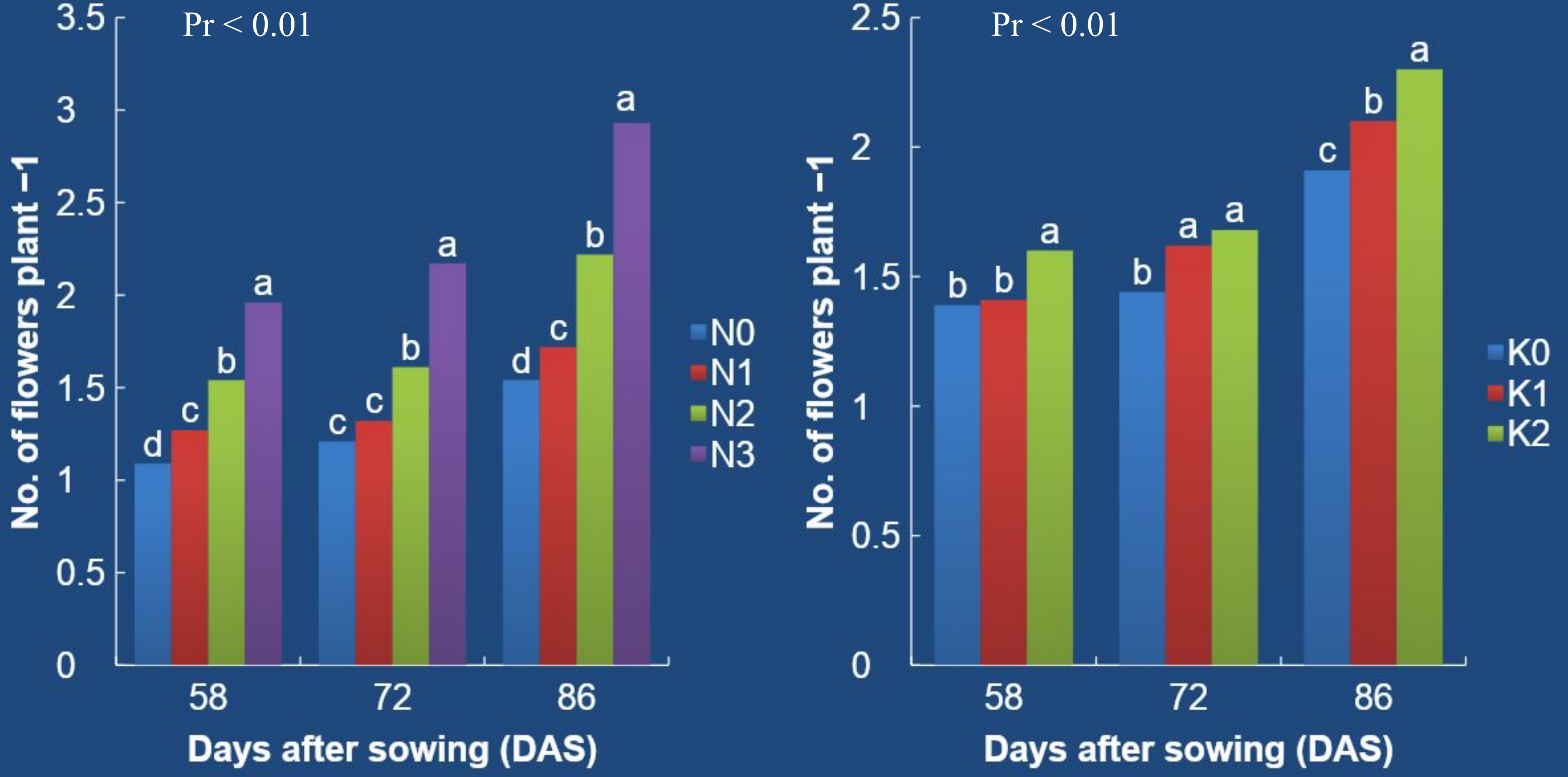


(a) Nitrogen application



(b) Potassium application

Figure 8. Mean values of no. of squares plant^{-1} as affected by nitrogen and potassium application in post-monsoon season, 2015-2016



(a) Nitrogen application

(b) Potassium application

Figure 9. Mean values of no. of flowers plant^{-1} as affected by nitrogen and potassium application in post-monsoon season, 2015-2016

Table 6. Yield and yield components as affected by nitrogen and potassium application (post-monsoon season, 2015-2016)

Treatments	No. of bolls plant^{-1}	Boll wt (g)	1000 seed wt (g)	Boll wt plant^{-1} (g)	Yield (kg ha^{-1})
Nitrogen (N)					
0 kg ha^{-1}	8.59d	3.26c	88.44c	24.30d	764.50d
60 kg ha^{-1}	10.57c	3.54b	94.00bc	32.30c	986.40c
120 kg ha^{-1}	13.70b	3.83a	100.00ab	45.16b	1345.50b
180 kg ha^{-1}	17.63a	4.10a	102.22a	61.30a	1835.80a
$LSD_{0.05}$	1.5	0.28	6.74	6.29	193.98
Potassium (K)					
0 kg ha^{-1}	10.63c	3.61	93.17	33.47c	994.60c
62.25 kg ha^{-1}	12.03b	3.62	96.33	39.11b	1179.70b
124.5 kg ha^{-1}	15.21a	3.83	99.00	49.72a	1524.90a
$LSD_{0.05}$	1.3	0.24	5.83	5.44	167.99
Pr>F					
N	**	**	**	**	**
K	**	ns	ns	**	**
N × K	*	ns	ns	*	*
CV%	12.19	7.73	7.17	15.77	16.09

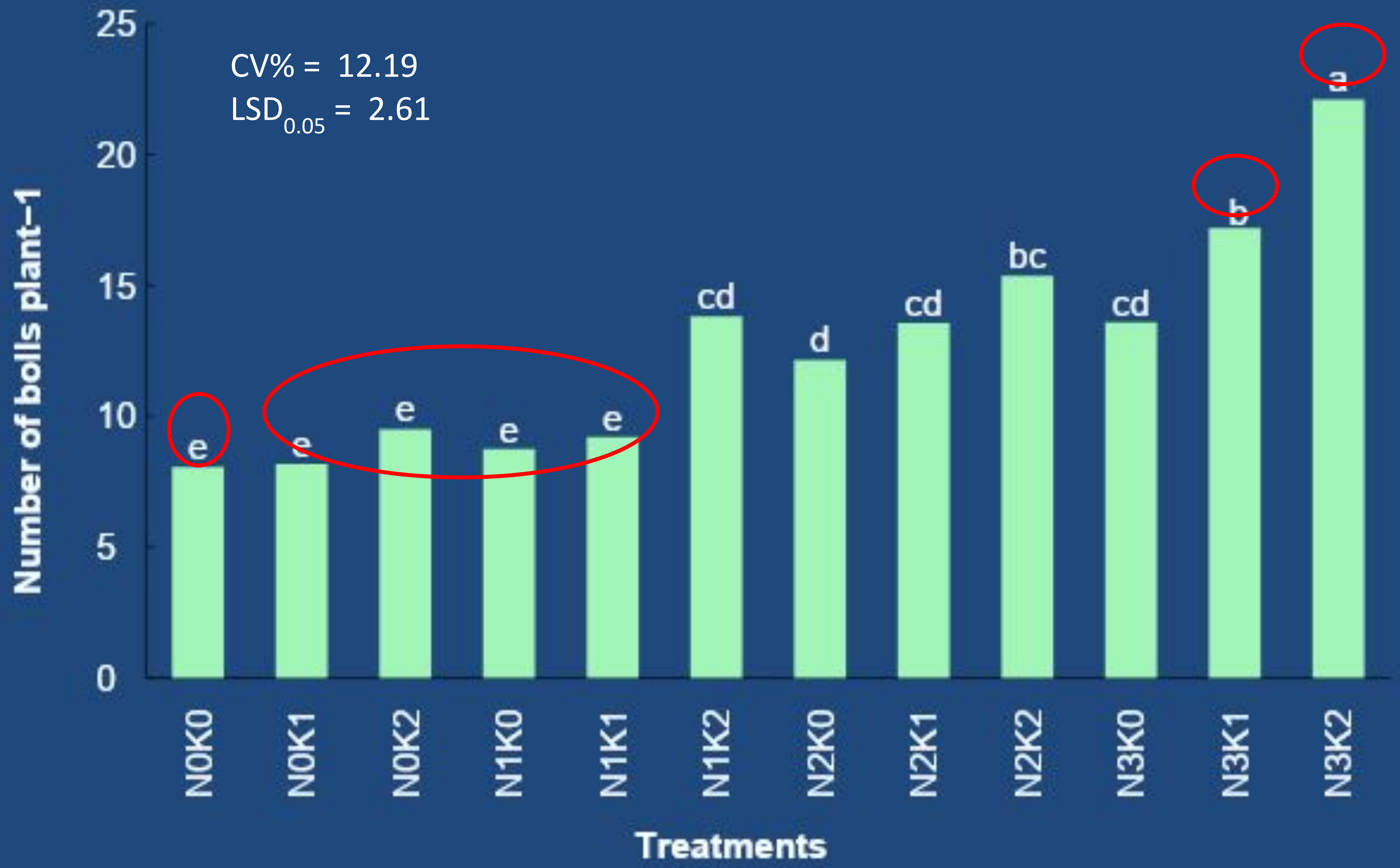


Figure 10. Combination effect of number of boll plant^{-1} as affected by N and K application in post-monsoon season, 2015

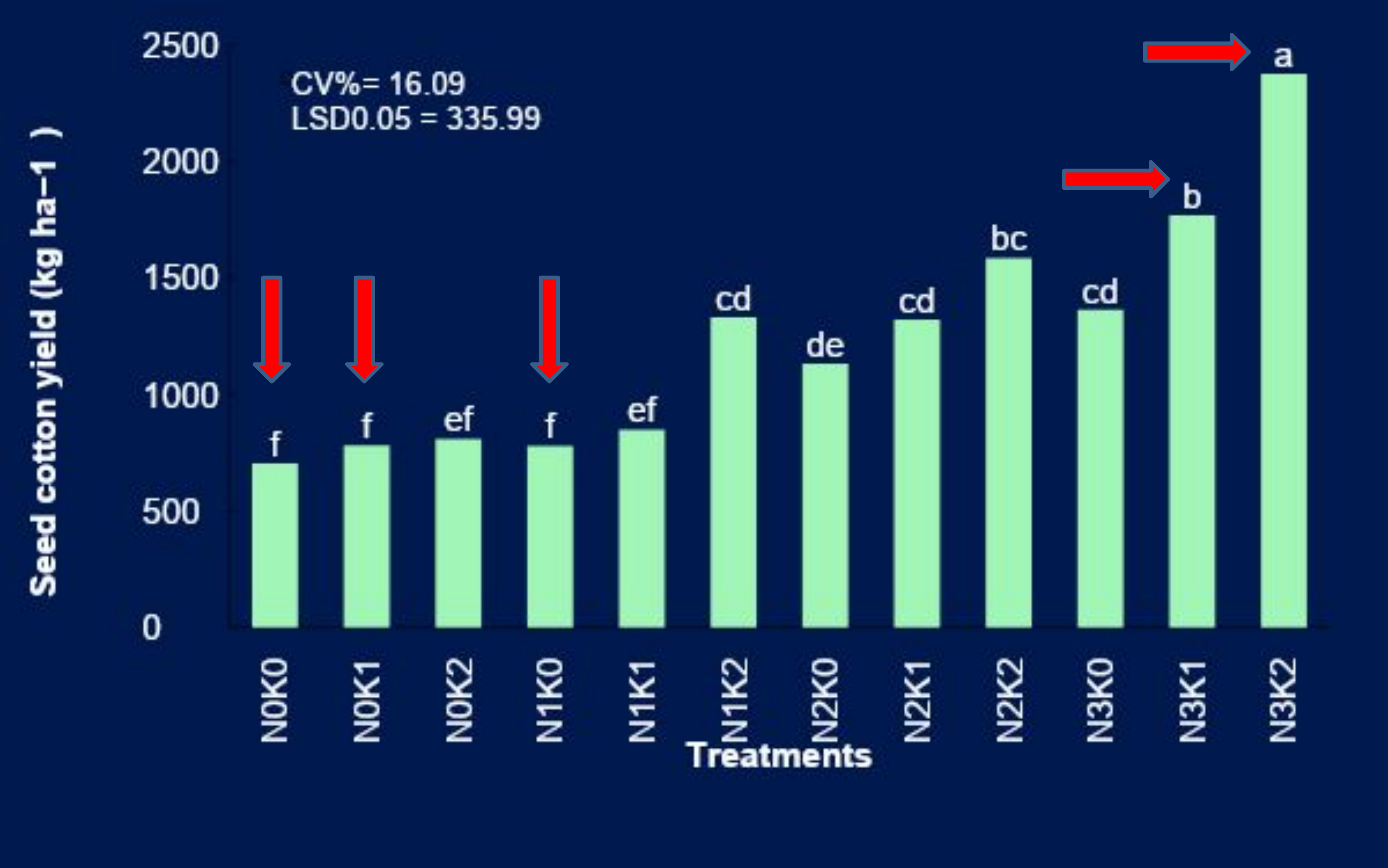


Figure 11. Combination effect of seed cotton yield (kg ha^{-1}) as affected by nitrogen and potassium application in post-monsoon season, 2015

Table 7. Effect of nitrogen and potassium application on fiber quality of cotton during post-monsoon season 2015-2016

Treatments	Fiber length (mm)	Fiber strength (lb mg^{-1})	Fiber fineness (micronair)	Maturity ratio	Ginning %
Nitrogen (N)					
0 kg ha^{-1}	30.44	7.97	4.72	1.07	38.79
60 kg ha^{-1}	31.11	7.96	4.93	1.13	38.01
Potassium (K)					
0 kg ha^{-1}	30.25b	7.95b	5.01	1.07b	38.39
62.25 kg ha^{-1}	30.58b	7.94b	4.74	1.09b	38.26
124.5 kg ha^{-1}	31.25a	8.08a	4.66	1.16a	38.03
$LSD_{0.05}$	0.55	0.09	0.34	0.06	1.10
Pr>F					
N	ns	ns	ns	ns	ns
K	**	**	ns	*	ns
N × K	ns	ns	ns	ns	ns
CV%	2.12	1.40	8.45	6.44	3.41

This finding was in line with **Dhindsa et al. (1975)** when K levels were insufficient or low, fiber elongation was reduced

Summary

- Plant growth, yield components and yield were highly significantly affected by N in both seasons
- No. of sympodial branches plant^{-1}, no. of bolls plant^{-1}, boll weight plant^{-1} and seed cotton yield were significantly affected by K in both seasons
- No. of bolls plant^{-1}, boll weight plant^{-1} and seed cotton yield were significantly affected by N × K interaction in both seasons

- For fiber quality, only maturity ratio was significantly affected by K in pre-monsoon season
- In post-monsoon season, fiber length, fiber strength and maturity ratio were significantly affected by K treatments

Conclusion

- N mostly influenced on growth and yield of cotton although no affect on fiber quality, whereas K was more pronounced for no. of sympodial branches, yield and fiber quality
- The results from all quality characteristics can be assumed that K is a key to increase the better fiber quality rather than N
- In both seasons, combine application of N and K indicated that the response of seed cotton yield to N was influenced by K, vice versa

- 180 kg N ha^{-1} with 124.50 kg K ha^{-1} might be the best fertilizer ratio for higher seed cotton yield and quality under the present study conditions
- Further investigations will be necessary to understand the response of N and K fertilization on cotton yield and quality under different soil fertility and climate conditions using different cultivars

Research Photo









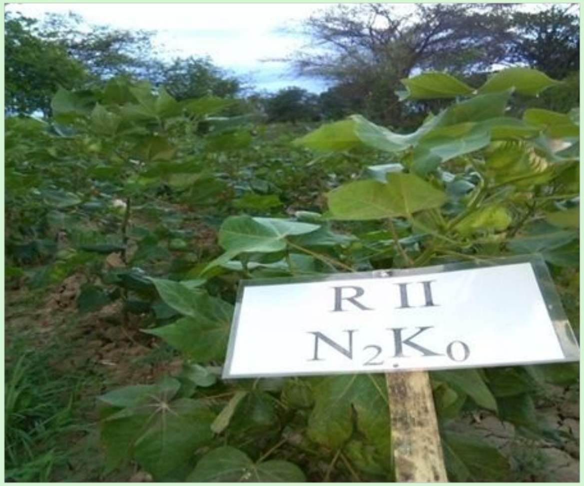


N3



R1
N1K1


R I
N_3K_0


R II
N_2K_0


R II
N_1K_2

Thank you