

IMPROVEMENTAL EFFECTS OF SOME NUTRITIONAL TREATMENTS ON MID-SEASON POOR VEGETATIVE GROWTH AND ITS CONSEQUENT PREMATURE CUT-OUT OF N-STRESSED COTTON PLANT

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ABSTRACT

Two field experiments were carried out at Mallawi Agric. Res. Station, EL-Minia Governorate, in 2005 and 2006 seasons. The aim of this investigation was to evaluate effects of some foliar nutritional treatments; Urea (2%), Magic (2%); Nofatrein (1L/fad); and Potassin N (1L/fad) and soil-applied N at rate of 30 kg N/fad on growth and productivity of mid-season poorly grown cotton plants of Giza 83 cultivar. Foliar treatments were applied twice; at early flowering stage and 3 weeks later, while the supplemental soil N were applied as one dose at early flowering stage. A randomized complete block design with four replicates was used. The main findings could be summarized as follows:

The results showed that the supplemental soil-applied N dose was the only treatment which gave a consistently significant increases in leaves content of chlorophyll, plant height, numbers of main stem nodes, fruiting branches, open bolls and total fruiting sites per plant, number of nodes above yellow flower and seed cotton yield per faddan in both seasons but it significantly decreased earliness percentage in comparison with the control in both seasons.

All used foliar treatments significantly increased leaves content of chlorophyll and exerted increases in plant growth and productivity but the significance level was not always reached in comparison with the control. No significant differences were observed among the four foliar treatments used in this study in both seasons.

It could be concluded that supplemental soil N dose of 30 kg N/fad at early flowering stage was more effective in enhancing vegetative growth, delaying cut-out and reducing yield loss of mid-season poorly grown cotton plants as compared with two sprays of any nutritional compound used in this study.

INTRODUCTION

Growth of cotton plant exhibits a very dynamic response to management and environment (Oosterhuis, 1990). Even slight changes in climate, soil water, nutrients availability, or pest damage can greatly affect the phenology of a cotton crop (Bourland *et al*, 1994). This makes some difficulties for cotton growers in controlling plant growth to be as nearest as possible to the optimal level for the relative growth stage that gives highest yield. As a consequence, yield losses are frequently observed in cotton fields across cotton belt of Egypt owing to either excessive or sub-optimal vegetative growth. To avoid or reduce such cotton yield losses, it is emphasized that growth rate of cotton plant should be closely monitored so that timely adaptive operations could be performed when needed to adjust the plant growth pathway at appropriate time. Of much significant is the early

prediction of growth deviation since once it occurs, yield losses occurs and then all possible efforts, extra costs, would be just for reducing such losses.

Much efforts have been paid to control excessive vegetative growth of cotton, while little attention has been devoted to find proper treatments for promoting growth of poorly grown plants that have a tendency to premature cut-out. Sub-optimal vegetative growth rate, during flowering stage in particular, is an actual trouble facing cotton growers especially in Upper Egypt, resulting in early cut-out with reduced yield potential, and further in severe growth limitations cotton plants could be markedly stunted, prematurely senesced, and produce much lower yield. The pronounced slowing down of growth, flowering and boll retention is referred to as cut-out which when occurs too early in growing season, the full yield potential of cotton will not be realized (Guinn, 1985 and Cothren, 1999).

Premature cut-out of cotton plant growth could be induced by many internal and external factors. Physiologically, cut-out is strongly affected by nutritional stress i.e. limited assimilates and nutrients available for vegetative growth due to the competition of fruit load, by changes in hormones balance in favour of growth inhibitors (ethylene and abscisic acid) at the expense of growth promoters (auxins, gibberellins and cytokinins), or by both factors (Guinn, 1985 and Cothren, 1999). Agronomically, several stresses could suppress cotton growth and impose early cut-out including; deficiency of nutrients especially N, water stress, temperature extremes, salinity or biotic stresses (Oosterhuis, 1990 and Cothren, 1999). Among them, nutrients deficiency, N in particular, seems to be the main factor imposing early termination of cotton growth under local conditions of Upper Egypt, and thus supplemental nutrition is thought can delay growth cut-out of cotton plant. It has been shown that N-deficient cotton plants showed slow nodal development, lower apogee and premature cut-out (Tewolde and Fernandez 1997; Zhao and Oosterhuis, 2001 and McConnel and Mozaffari, 2004). N stress has been found to decrease photoassimilates formation rate (Bondada *et al*, 1996 and Reddy *et al*, 1996) and to decrease levels and activities of gibberellins and auxins in cotton plants (Mahmoud *et al*, 1994).

In Egypt, the only recommended treatment to ameliorate poor growth of cotton after flowering initiation is foliar application of Urea. Otherwise, positive responses of cotton growth and yield to foliar application of Urea are not always consistent possibly due to only a small amount of N can be applied at each spray (Oosterhuis *et al*, 2000). Meanwhile, many nutritional compounds that may help in this respect are commercially available. On the other hand, recent research has shown economic yield responses of irrigated cotton for late soil N application, during flowering stage, probably owing to better matching between N supply and its uptake and utilization by plant (Ebelhar and Spurgeon, 1987; Maples *et al*, 1990; Ebelhar, 1990 and Mullins *et al*, 2003).

Thus, the main objective of the present study was to compare effects of some foliar and soil treatments as supplemental nutrition to remediate mid-season poor growth and early cut-out of cotton plant under the environmental conditions of EL-Minia district.

MATERIALES AND METHODES

Two field experiments were carried out at Mallawi Agric. Res. Station, Minia Governorate, in 2005 and 2006 seasons. This investigation aimed at comparing effects of some foliar-and soil-applied nutritional treatments of some commercial fertilizers on promoting mid-season poor vegetative growth and delaying cut-out of cotton plants of Giza 83 cultivar. Mid-season poor growth was imposed by reducing nitrogen (N) rate to be 30 kg N/fed applied in the form of ammonium nitrate (33.5%N) as a single dose at thinning. The treatments included in this study were:

- 1- Control (30 kg N/fed at thinning stage with no nutritional application).
- 2- Two foliar applications of 2% Urea (46.5%N).
- 3- Two foliar applications of 2% Magic (10%N; 1%P and 43%K).
- 4- Two foliar applications Nofatrein (5%N, 5%P , 5%K and micronutrients) at the rate of 1 L/fed.
- 5- Two foliar applications of Potassin N (8%N and 30%K) at the rate of 1 L/fed.
- 6- Supplemental soil-applied N dose of 30 kg N/fed at early flowering stage.

A randomized complete block design with four replicates was used. Plot area was 13 m² including 5 ridges; 4 m long and 65 cm apart. Planting date was during the last week of March in both seasons. Foliar nutritional treatments were applied twice, at early flowering and three weeks later, while the supplemental soil-applied N dose of 30 kg N/fed were applied at early flowering stage. Other management practices were done as recommended. Nofatrein and Potassin were received from General Organization for Agriculture Equalizations Fund (GOAEF). While Magic was supplied by Technogreen Group, Ismailia Sq. Heliopolis, Cairo, Egypt.

In the second season, samples of the topmost fully expanded leaves were taken 2 weeks after the 2nd spray of treatments to determine leaf content of chlorophyll a and b according to Arnon (1949).

Commencing on 19 June (about 85 days after sowing) and at about 10 days intervals in both seasons, 10 plants with a fresh yellow (a flower of that day) on the first fruiting position (the nearest fruiting site on a sympodia to main stem) were randomly chosen from the middle 3 rows of each plot for counting number of main-stem nodes above the uppermost yellow flower (NAYF) on the first fruiting position according to Bourland *et al* (1992) as indicator of the crop progress towards maturity.

At harvest, 6 plants were chosen at random from the central row of each plot to estimate the following growth and yield attributes: plant height (cm) main stem nodes, internode length, fruiting branches, open and unopen bolls and aborted and total fruiting sites. Fruit shedding % was calculated as (aborted fruiting sites ÷ total fruiting sites) x 100. Seed cotton yield (kentar/fed) was calculated at the basis of plot yield. Earliness% was calculated as (1st pick yield ÷ total yield) x 100. Samples of 25 bolls from each plot were weighted and ginned to determine boll weight (gm), lint % and seed index.

All collected data were subjected to statistical analysis according to Gomez and Gomez (1984). Some physical and chemical properties of the experimental soil in both seasons are shown in Table (1).

Table (1): Some physical and chemical properties of the experimental soil in 2005 and 2006 seasons.

Soil properties	2005	2006
Texture	Sitly clay loam	Sitly clay loam
E.C. (mmohs/cm)	1.30	1.35
pH (1 : 2.5) soil : water ratio	8.20	8.15
Organic matter	1.16	1.24
Available N (ppm)	19.75	22.35
P (ppm)	5.35	5.85
K (ppm)	168	178

RESULTS

1- Leaves content of chlorophyll:

Results shown in Table (2) clearly reveal that both foliar and soil feeding treatments exhibit, in general, a significant increase in leaves content of chlorophyll a, b and total chlorophyll as compared with the N-stressed control. Supplemental soil application of N significantly increased leaves content of chlorophyll in comparison with all foliar-applied treatments except Magic treatment which gave higher values of chlorophyll than other foliar treatments without significant differences among them it could be noticed that total chlorophyll was increased by 20.4% with using supplemental applications of 30 kg N/fad compared with the control.

2- Plant growth parameters:

It could be seen from Table (2) that, plant height, number of main stem nodes, number of fruiting branches per plant were significantly increased in both season with soil N application only and by foliar application of Urea or Magic in 2006 only in comparison with the control. Internode length was not significantly affected by all treatments in both seasons. No significant differences were observed among foliar-applied treatments in relation to growth parameters in both seasons. Supplemental soil application of N was more effective in promoting plant growth as compared with foliar nutrition in both seasons it could be concluded that the supplemental soil N dose significantly increased plant height by 10.9 and 9.8 %, number of main stem nodes by 10 and 7.8 % and number of fruiting branches by 17.7 and 14.6 % compared with the control in the first and second seasons, respectively.

3- Nodes above yellow flower (NAYF):

Results presented in Table (3) show that number of main stem nodes above the uppermost yellow (fresh) flower on the first fruiting position of a sympodia (NAYF) was significantly increased by soil N application commencing on June 28 in 2005 season and on July 5 on 2006 season, and by foliar application by urea or Magic only on July 15 in 2006 season only in comparison with the control. It could be implied that cut-out of cotton plants was more delayed by soil N application than by foliar feeding in both seasons. It could be noted that supplemental soil N recorded the highest number of nodes above the yellow flower in both seasons.

Table (3): Effect of some nutritional treatments on number of nodes above a first position yellow flower (NAYF) of N-stressed cotton in 2005 and 2006 seasons.

Treatments†	Date	2005 Season				2006 Season			
		19/6	28/6	6/7	16/7	19/6	27/6	5/7	15/7
Control (no supplemental nutrition)		6.1	4.6	3.7	2.9	7.5	6.2	4.9	3.9
‡ 2 sprays of urea (2%)		6.5	5.2	3.8	3.2	7.6	6.3	5.4	4.9
‡ 2 sprays of Magic (2%)		6.6	5.4	3.8	3.4	7.7	6.5	5.5	4.9
‡ 2 sprays of Nofatrein (1L/fed)		6.4	5.1	3.9	3.2	7.8	6.6	5.5	4.7
‡ 2 sprays of Potassin N (1L/fed)		6.3	5.3	4.1	3.2	7.6	6.4	5.3	4.4
” Soil-applied N (30kg N/fed)		7.1	6.4	5.1	4.2	7.8	7.0	6.0	5.3
L.S.D. 5%		N.S.	1.2	0.9	1.1	N.S.	N.S.	0.8	1.0

† All treatment received a soil N dose of 30 kg/fed at thinning.

‡ Foliar sprays were applied at early flowering stages and three weeks later.

” Supplemental soil N dose was applied at early flowering stage.

4- Yield and its components:

Results in Table (4) reveal that supplemental soil-applied N significantly increased numbers of open bolls and total fruiting sites per plant and seed cotton yield per faddan in both seasons, and seed index in 2005 only and boll weight in 2006 only; but it significantly decreased earliness% in comparison with the control in both seasons. Similar trend was generally obtained for foliar nutrition in both seasons but significant increase was reached only in number of fruiting sites per plant and seed cotton yield in 2006 season and in seed index in 2005 season. Both foliar and soil treatments exerted no significant effects on number of unopen bolls, aborted fruiting sites, fruit shedding % and Lint % in both seasons. Soil N treatment gave more pronounced enhancement in yield and yield components as compared with foliar feeding in both seasons it could be concluded that supplemental soil-applied N dose increased number of open bolls per plant by 24.1 and 20.2 %, total fruiting sites per plant by 23.3 and 22.8 % and seed cotton yield by 16.8 and 15.4 % compared with the control treatments in the first and second seasons, respectively.

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DISCUSSION

The trouble of premature cut-out observed in cotton fields in Upper Egypt is usually preceded by mid-season restricted vegetative growth mainly imposed by nutritional stress, N stress in particular. The tendency to early cut-out of cotton plant is morphologically discovered often lately during flowering stage as fruiting sinks increase and metabolites available for vegetative growth is reduced. Thus, the most efficient means to avoid such trouble is to be earlier predicted, using monitoring techniques of plant growth rate and plant N status, when it could be earlier ameliorated by soil-applied fertilizers during the optimal period for soil application with maximum root activities. Under the lack of such monitoring techniques, the early prediction of premature cut-out is difficult. Delayed discovering of such trouble may favour the use of foliar nutrition and may restrict the use of soil feeding to rectify it. Thus, it was argued that soil application of N during flowering stage could give economic responses of cotton under such situations.

Results of this study showed that both foliar and soil-applied treatments positively affected growth and productivity of cotton plant but such positive effects were more pronounced with soil N application which was the only treatment that gave a consistently significant enhancement in plant growth and yield in comparison with the control in both seasons. The four foliar treatments gave statistically similar effects on plant growth and yield in both seasons. The positive effects for foliar or soil supplemental nutrition could be owing to improving nutritional status within plant, leaf N in particular. Earlier studies have shown that increasing N supply increased leaf N especially leaf N associated with photosynthetic apparatus i.e. chlorophyll and photosynthetic enzymes since N is an important constituent of both (Reddy *et al*, 1996). This may enhance leaf and canopy photosynthesis (Reddy *et al*, 1996 and Zhao and Oosterhuis, 2001), which may increase the available photosynthates for vegetative growth which may encourage nodal development and overall vegetative growth. Numerous previous studies indicated that N-deficient cotton typically undergoes chlorosis, slow nodal development, and reduced overall vegetative growth (Bondada *et al*, 1996; Tewolde and Fernandez, 1997 and El-Shahawy and Abd-El-Malik, 1999).

The obtained results also showed that number of main stem nodes above the uppermost first-position yellow flower (NAYF) tended to increase with supplemental nutrition particularly soil one. Many reports have shown that number of nodes above white flower (NAWF) is a signal of physiological cut out of cotton plant (Abaye *et al*, 1999) and further it could be a useful tool in making in-season and end-of-season efficient decisions regarding N management, pest applications, last irrigation, ceasing insecticide application and harvest-aids application (Bourland *et al*, 1992; Bourland *et al*, 1994 and Cothren, 1999). Decreasing NAWF is an indicator of plant progress to cut-out. Therefore, NAYF was used in the present study to evaluate effects of the supplemental nutritional treatments on the crop progress towards cut-out (Abaye *et al*, 1999 and Cothren, 1999).

The relatively stimulative effects for supplemental nutrition, particularly soil-applied N, on plant vegetative growth may explain the observed increase in NAYF especially with soil N application which exhibited a delay in growth cut-out of cotton plant as compared with the control. The relative delay in cut-out may leads to increase the second pick yield which may explain the significant reduction in earliness% due to soil N application. Similar results indicated that N supply delay growth cut-out of cotton plant (Reddy *et al*, 1996 and McConnell and Mozaffari, 2004).

Results also revealed that cotton yield and some yield components were increased by supplemental nutrition especially soil N application. This trend could be correlated to the promotive effects on plant vegetative growth since vegetative growth not only determines plant fruiting capacity expressed as number of sympodia and total fruiting sites, but also it affects plant fruiting efficiency through acting as assimilates supplier to the fruiting load. Response of cotton yield and its components to N supply is well documented (Assy and Abdel-Malak, 1997; Khalil, 1998 and Mullins *et al*, 2003).

It is clear from obtained results that soil-applied N was more efficient in enhancing growth and yield of mid-season poorly grown cotton plants as compared with the four foliar nutritional treatments used in this study. The small amount of nutrient (s) that could be applied at any, spray is a well-known shortcoming of foliar nutrition in general (Zhao and Oosterhuis, 2001). On the other hand, many reports have shown that modern early-maturing and heavily-fruited cotton cultivars may benefited from early flowering soil N application especially irrigated cotton; Maples *et al* (1990) reported that soil N application is usually suggested during the first 3 weeks of blooming because root activity is usually good at that time. Ebelhar (1990) reported that yield of irrigated cotton grown in alluvial soil was increased by delayed soil N dose until mid-bloom. Positive cotton responses to delayed soil N application may be due to its better matching between N supply and its uptake and utilization by cotton plant, since peak N uptake and demand by cotton plant occurs from first square to peak-bloom (Silvertooth and Norton, 1999 and Mullins *et al*, 2003), with two-thirds of the cotton plant's N taken up after early bloom (Mullins *et al*, 2003).

It could be concluded from this study that. To ameliorate mid-season poor growth of cotton, a dose of soil N exerted better response than those of two sprays of any used nutritional compound.

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تأثير بعض معاملات التغذية لعلاج ضعف النمو الخضري في مرحلة التزهير وما ينتج عنه من ربط مبكر لنبات القطن المعرض للإجهاد النتروجيني
محمد محمد أحمد قاسم، عالية محمود عوض ناميش و سناء جمعه جبالى
معهد بحوث القطن - مركز البحوث الزراعية - الجيزة

أجريت تجربتان حقليتان بمحطة البحوث الزراعية بملوى - محافظة المنيا - خلال موسمي الزراعة ٢٠٠٥، ٢٠٠٦ لدراسة استجابة نمو ومحصول نباتات القطن (صنف جيزة ٨٣) والتي تعاني من ضعف النمو الخضري في مرحلة التزهير مع الميل للتوقف المبكر للنمو لبعض معاملات التغذية الخضريّة: يوريا (٢%)، ماجيك (٢%)، نوفاترين (١ لتر/ف)، بوتاسين ن (١ لتر/ف) وكذلك للإضافة الأرضية للسماد النتروجيني (٣٠ كجم/ن/ف) بهدف تحسين النمو الخضري وتأخير توفقه وبالتالي تقليل النقص في المحصول. تم رش معاملات التغذية الخضريّة مرتين الأولى في بداية التزهير والثانية بعدها بثلاثة أسابيع بينما تم إضافة جرعة النيتروجين الأرضية الإضافية عند بداية التزهير تم تنفيذ التجربتين في تصميم القطاعات الكاملة العشوائية في أربع مكررات.

ويمكن تلخيص أهم نتائج الدراسة فيما يلي :

- أظهرت الإضافة الأرضية للسماد النتروجيني إلى زيادة معنوية في محتوى الأوراق من الكلوروفيل وطول النبات وعدد عقد الساق الرئيسي وعدد الأفرع الثمرية وعدد اللوز المتفتح وعدد عقد الساق الرئيسي فوق الزهرة الصفراء على الموقع الثمري الأول وكذلك محصول القطن الزهر (قنطار/ف) بينما أدت إلى نقص معنوي % للتبكير مقارنة بالكنترول في كلا الموسمين .
- أظهرت كل معاملات التغذية الخضريّة زيادة معنوية في محتوى الأوراق من الكلوروفيل وكذلك إلى زيادة صفات النمو والمحصول ومكوناته لكن الفروق لم تكن دائمة معنوية مقارنة بالكنترول . لم تكن هناك فروق جوهرية بين معاملات التغذية الخضريّة المستخدمة في هذه الدراسة في كلا الموسمين.
- أوضحت هذه الدراسة أن الإضافة الأرضية لجرعة نتروجين (٣٠ كجم/ف) في بداية التزهير كان أكثر فاعلية في تحسين النمو الخضري وتأخير توفقه وتقليل نقص محصول نباتات القطن التي تعاني من ضعف النمو الخضري في مرحلة التزهير مقارنة بالتغذية الخضريّة مرتين بأى من المركبات السمدية المستخدمة تحت الظروف البيئية لهذه الدراسة.

Table (2): Effect of some nutritional treatments on leaves content of chlorophyll and some growth parameters of N-stressed cotton in 2005 and 2006 seasons.

Season	2006			2005				2006			
	Chlorophyll (mg/g dry weight)			Plant height (cm)	No. of main stem nodes per plant	Internode length (cm)	No. of fruiting branches/plant	Plant height (cm)	No. of main stem nodes per plant	Internode length (cm)	No. of fruiting branches/plant
	Ch a	Ch b	Total ch1								
Control (no supplemental nutrition)	2.91	1.41	4.32	78.5	20.6	3.81	11.6	86.3	21.3	4.05	12.9
‡ 2 sprays of urea (2%)	3.35	1.55	4.90	80.4	21.3	3.77	12.7	90.8	22.3	4.07	13.9
‡ 2 sprays of Magic (2%)	3.52	1.58	5.10	82.1	21.8	3.77	12.9	91.1	22.4	4.07	14.2
‡ 2 sprays of Nofatrein (IL/fed)	3.28	1.48	4.76	80.0	21.5	3.72	13.0	89.4	21.9	4.08	13.8
‡ 2 sprays of Potassin N (IL/fed)	3.36	1.51	4.87	81.3	21.7	3.75	12.6	88.2	21.6	4.08	13.6
” Soil-applied N (30kg N/fed)	3.68	1.75	5.43	88.1	22.9	3.85	14.1	95.7	23.1	4.14	15.1
L.S.D. 5%	0.29	0.13	0.37	4.8	1.2	N.S.	1.6	3.8	1.0	N.S.	0.9

† All treatment received a soil N dose of 30 kg/fed at thinning.

‡ Foliar sprays were applied at early flowering stages and three weeks later.

” Supplemental soil N dose was applied at early flowering stage.

Table (4):Effect of some nutritional treatments on yield and its components of N-stressed cotton plants in 2005 and 2006 seasons.

Treatments†	No. of open bolls/ plant	No. of unopen bolls/ plant	No. of aborted fruiting sites/ plant	Total fruiting sites/ plant	Fruit shedding %	Boll weight (g)	Seed cotton yield (kentar/ fad)	Earliness %	Lint %	Seed index
2005 season										
Control	10.1	3.2	7.4	20.7	35.7	2.60	6.92	67.2	41.9	9.6
‡ 2 sprays of urea (2%)	11.5	3.6	7.5	22.6	33.2	2.69	7.53	66.2	42.1	10.2
‡ 2 sprays of Magic (2%)	11.7	4.7	7.7	24.1	31.9	2.71	7.66	66.2	41.3	10.0
‡ 2 sprays of Nofatrein (1L/fed)	11.8	4.4	7.4	23.6	31.4	2.72	7.55	64.7	41.6	10.1
‡ 2 sprays of Potassin N (1L/fed)	11.5	3.8	7.6	23.2	32.8	2.69	7.49	65.5	41.3	10.0
" Soil-applied N (30kg N/fed)	13.3	5.4	8.3	27.0	30.7	2.76	8.32	61.1	41.1	10.3
L.S.D. 5%	1.7	N.S.	N.S.	4.1	N.S.	N.S.	0.76	5.4	N.S.	0.2
2006 season										
Control	9.5	5.4	8.4	23.3	36.1	2.50	6.60	71.8	41.3	9.7
‡ 2 sprays of urea (2%)	11.1	7.3	9.3	27.7	33.6	2.64	7.32	65.6	41.2	9.9
‡ 2 sprays of Magic (2%)	11.3	6.9	8.9	27.1	32.8	2.62	7.42	67.0	41.2	10.0
‡ 2 sprays of Nofatrein (1L/fed)	10.5	7.2	8.8	26.5	33.2	2.60	7.29	66.4	41.0	10.0
‡ 2 sprays of Potassin N (1L/fed)	10.4	6.7	8.6	25.7	33.5	2.59	7.08	69.6	41.2	9.9
" Soil-applied N (30kg N/fed)	11.9	8.5	9.8	30.2	32.5	2.70	7.80	65.1	40.9	10.1
L.S.D. 5%	2.3	N.S.	N.S.	3.6	N.S.	0.12	0.57	5.7	N.S.	N.S.

† All treatment received a soil N dose of 30 kg/fed at thinning.

‡ Foliar sprays were applied at early flowering stages and three weeks later.

" Supplemental soil N dose was applied at early flowering stage.