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Content

The Cotton Innovations Newsletter is published twelve times annually. Contributed articles, pictures, cartoons, and feedback are welcome at any time. Please send contributions to the General Editors (see below). The editors reserve the right to edit. The deadline for contributions is one month before the publication date.

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News

World Cotton Day 2022 Cairo Egypt, has a different flavour

The ICAC is running four Twitter contests, one of which is dedicated to research. The rules of the contest can be found here, it runs from 1 September to 6 October, and the winner gets $1000 while the runner-up gets $500:
https://www.worldcottonday.com/location/international-cotton-advisory-committee-icac-2/

During the WCRC, there will be two World Cotton Day contests sponsored by the ICAC: one for best live presentation, and the other for best poster. Each awards the winner $1000 and the runner-up $500 as well. The explanation for this contest is also on the above link.

Use of non-conventional water to develop cotton cultivation in Iran

Ghorban Ali Roshani

Associated Professor, Cotton Research Institute of Iran, Agricultural Research, Education and Extension Organization (AREEO), Gorgan,Iran.

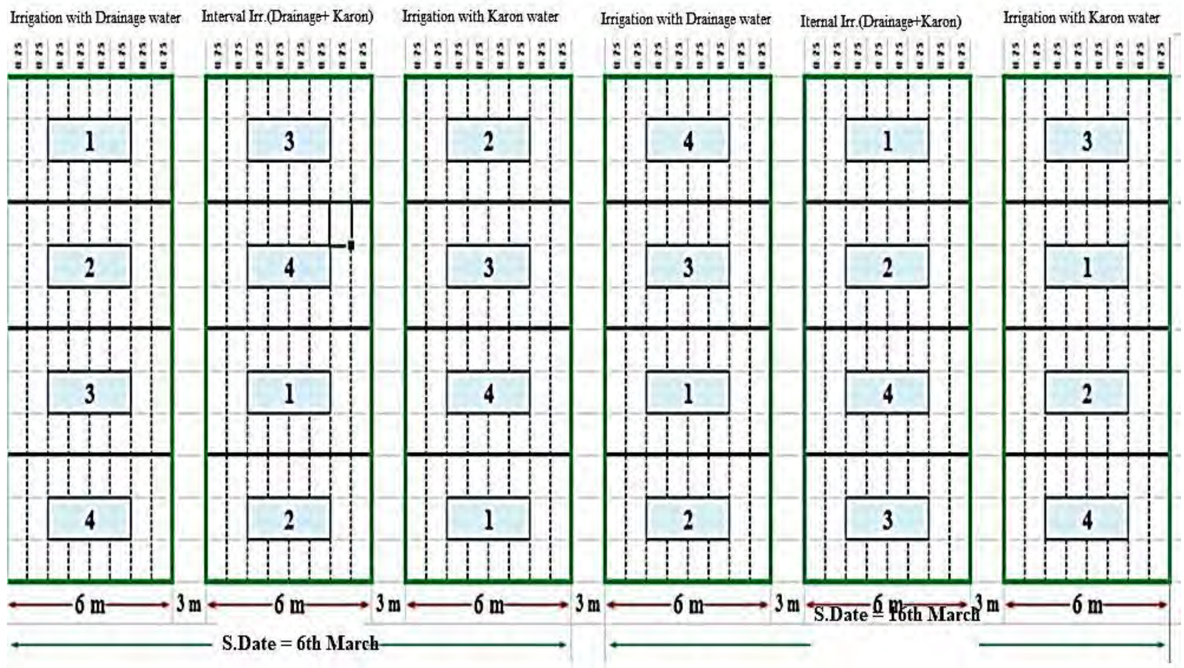
*** Email of Corresponding Author: ghroshani69@gmail.com**

Problem definition and topic importance:

Khuzestan province is located in the southern part of Iran with a very hot and humid climate and is the most important producer of wheat and sugarcane in the country. Khuzestan has several large agro-industries fields that are engaged in sugarcane production. Irrigation water for agriculture and industry is supplied from Karon River, the salinity of which varies between 2 and 3 dS/m depending on the season. In recent years, the high volume of drainage water (EC= 6-7 dS/m) coming out from sugarcane fields in south of Ahvaz has become a major environmental problem, so that only the water from the drainage of two agro-industries fields with 25,000 hectares' land area, a 35,000-hectare saltwater wetland with 250 million cubic meters of drainage water has been created.

Due to the increasing salinity of water in this artificial wetland (up to 80 dS/m), the officials of Khuzestan Water and Electricity Organization are looking for decreasing the new area with optimal efficiency of these drained water. In order to make optimal use of wastewater and prevent environmental pollution and also to develop the area under cultivation and irrigated lands, salinity-resistant plants can be cultivated. Cotton is one of the most suitable salinity-resistant plants that has good compatibility with salinity conditions of water and soil of Khuzestan. For this purpose, the effect of three irrigation treatments on 4 cotton cultivars in two planting dates in Mirza Kuchak Khan agro-industry Company of Ahvaz during 2018 and 2019 was investigated. The experimental design was in the form of double split plots with 4 replications.

Dates of March 6 and March 16 as main plot, irrigation treatments including sugarcane drainage with salinity of 6 dS / m, Karon river water with salinity of 2.5 dS/ m, and sugarcane drainage and Karon water alternately (intermittently) as Cotton cultivars including Khorshid, Sajedi, Golestan and Khordad were considered as sub-sub plots.



1= Golestan 2= Khorshid 3= Sajedi 4= Khordad

Figure 1- Experimental plan for the experiment in Research Farm

Figure 2- Cotton field irrigated with drainage water during the growing season

Results and discussion:

Cotton is a sensitive crop to salinity in the early stages of germination, so it is better to use water with less salinity or fresh water for early irrigation for emergence. In case of intermittent use (one in between) of drainage and Karon water, we will be able to save up to 50% in water consumption without significantly reducing performance.

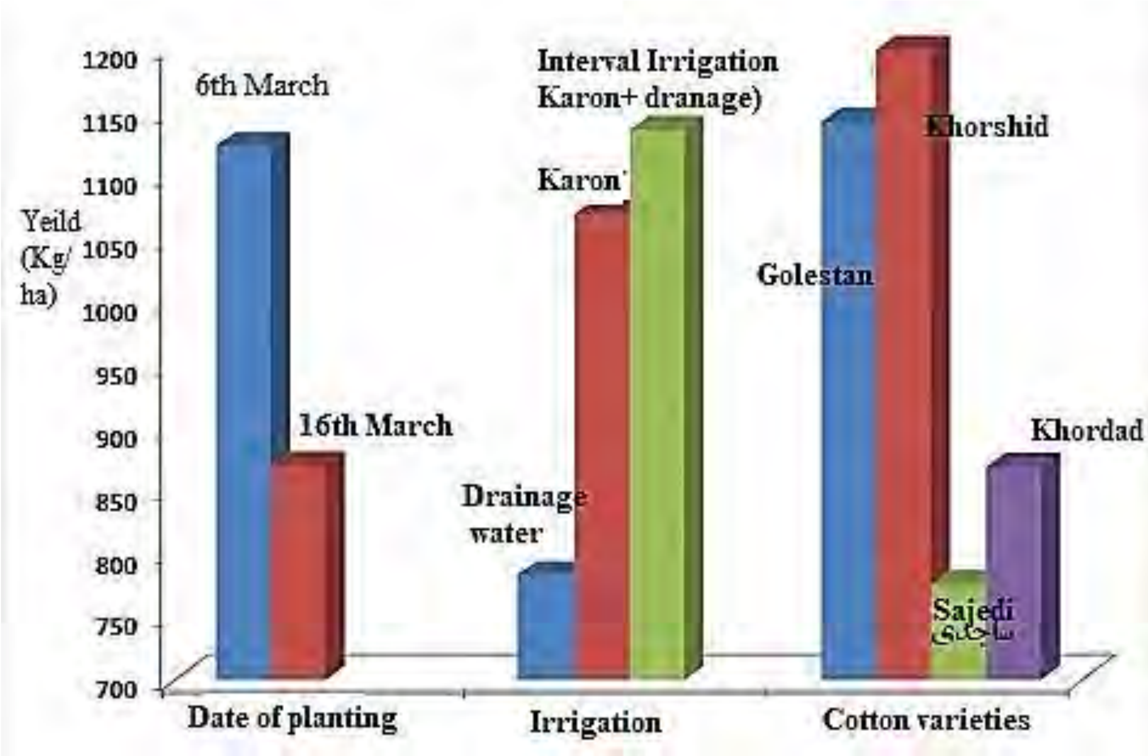


Figure 18- Yield of cotton under the influence of planting date, irrigation and cultivar

The results showed that the average yield of cotton cultivars on the first sowing date (6th March) was 29% higher than the second sowing date (16th March).

The weight of boll and the percentage of cotton fibers in the two planting dates were not significantly different. The early ripening percentage of the second planting date was higher. The yield of cotton in irrigation with Karon water and intermittent irrigation of Karon water and drainage were not significantly different.

Yield of cotton with drainage was 26.7% lower than Karon river water and periodic irrigation (drainage water and Karon). The highest weight of boll, percentage of maturity and percentage of fiber was related to periodic irrigation.

The highest yield of cotton cultivars was related to Golestan and Khorshid cultivars. Golestan cultivar was heavier; but Khorshid cultivar had a higher percentage of maturity and a higher percentage of fiber than other cultivars.

With the help of the findings of this study and cultivation of Khorshid and Golestan cotton cultivars on March 6 in southern Khuzestan and irrigating intermittently with Karon river and drainage water of sugarcane fields, while reducing the environmental risks, the resulting drainage water can produce some industrial crops like cotton and create jobs for the cotton growers in Khuzestan province.

It is suggested that the planting methods in saline soil and water conditions and the yield of cotton in different irrigation and nutrition managements in terms of agricultural wastewater use to be studied.

Due to the fact that cotton shows a great reaction to the irrigation regime and the amount of irrigation water, it is suggested that different treatments of irrigation water management and irrigation regime be studied.

By using early mature cultivars or planting the cotton seedlings it may be possible to prevent severe temperature damage and scorching winds with proper timing of seedling transfer to tolerate the existing conditions by regulating physiological activity and preserving the flowers.

Figure 3- Outlet of the drainage system in Mirza kuchak khan agro-industry

Figure 4- Irrigation and measurement of water consumption with flume

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Value of World Natural Fibre Production Rose to $85 Billion in 2021

Terry Townsend, Statistician, DNFI

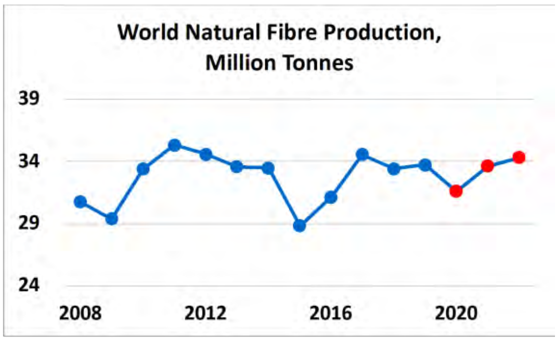
June 23, 2022

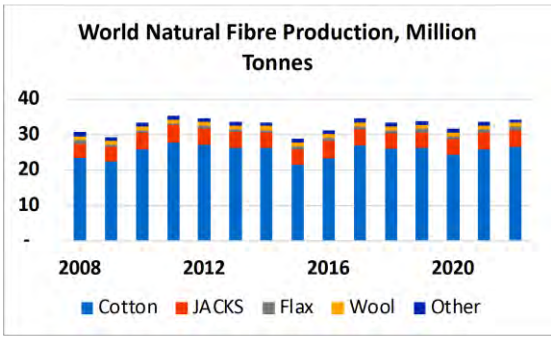
The value of world natural fibre production at the producer level leapt from US$55 billion in 2020 to $85 billion in 2021, as both prices and production increased.

World natural fibre industries have proven to be highly resilient in the face of multiple challenges in recent years. Covid-related lockdowns shuttered textile mills in many countries for months during 2020 and 2021, interrupting consumption of natural fibres for apparel and home furnishings. Hundreds of Western brands and retailers abruptly cancelled billions of dollars in orders resulting in displacement of millions of workers, many order cancellations were retroactive, thus affecting shipments already on the water.

Travel restrictions and quarantines led to labor shortages which disrupted production activities in industries as diverse as sisal harvesting in Brazil and sheep shearing in Australia and New Zealand. Supply chain disruptions, including shortages of containers, reduced sailings to and from South America, Africa and South Asia, combined with port backlogs around the world, disrupted trade in natural fibres. Trade disputes involving China disrupted trade in cotton, cotton products and wool fibre.

Despite these difficulties, world natural fibre production recovered fully in 2021 from declines which occurred during 2020, and production in 2022 is estimated at more than 34 million tonnes, nearly record high.





Overview of World Fibre Production

World fibre production is estimated at 120 million tonnes in 2021, or about 15 kilograms for every person on earth. The total included 86 million tonnes of manmade fibre and 34 million tonnes of natural fibre. Of the natural fibre total, cotton accounted for about 26 million tonnes, while production of jute, abaca, coir, kenaf and sisal (JACKS) reached 5 million tonnes. All other natural fibres together, including wool, linen, hemp, kapok and ramie, totalled 3 million tonnes.

Between 2010 and 2021, production of oil-based and wood-based manmade fibres rose from 52 million tonnes to an estimated 86 million tonnes, while natural fibre production remained in a range between 28 million tonnes and 35 million tonnes. As a result, the share of natural fibres in world fibre production dropped from 37% to 28% over the last decade.

Importance of Natural Fibres

Natural fibre industries are engines of economic growth and contribute to the achievement of sustainable development goals. The value of natural fibre production at the producer level during 2021 is estimated at US$85 billion, and an estimated 40 million households earn their livelihoods from the production of natural fibres. When seasonal employment is included, approximately 200 million people, or more than 2% of the world's population, work in the agricultural segments of natural fibre value chains.

World Production, Value and Employment of Natural Fibres, 2021

	Production	Households	Value of Production
	Estimated	Thousands	$Billion
Natural Fibers	Metric Tons		
Vegetable Origin			
Abaca	82,000	112	$0.2
Bastfibres, other	229,000	217	$0.1
Coir, without pith	1,120,000	600	$0.3
Cotton Lint	25,800,000	23,340	$68
Fibre crops not specified elsewhere	270,000	200	$0.3
Flax fibre and tow, ex scutching mill	1,028,000	10	$0.8
Hemp tow waste	240,000	228	$0.2
Jute, Kenaf & Allied Fibres	3,164,436	6,000	$4
Kapok fibre	90,000	85	$0.5
Ramie	59,000	56	$0.1
Sisal, Henequen and similar hard fibers	260,000	52	$0.4
Silk, raw	172,000	3,000	$1.7
Wool, clean	1,033,570	5,000	$8
Other animal fibres*	26,460	85	$0.4
Total Natural Fibers	34,000,000	40,000	$85

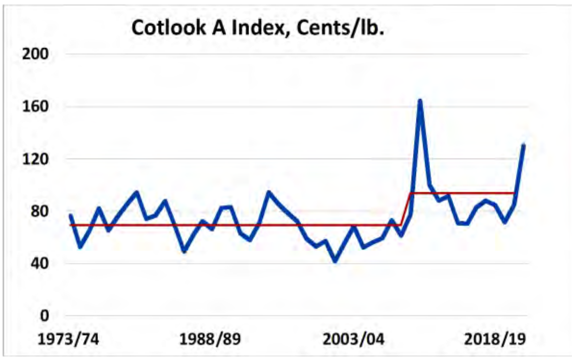
Natural fibres connect people to markets. Natural fibres are durable, storable commodities that do not require refrigeration, are immune from vermin, and can be transported long distances without damage. Natural fibres have high ratios of value to weight and density, making international trade feasible. Natural fibres are grown on the frontiers of the world economy in a variety of climates and agronomic zones, often in areas where other agricultural activities are not possible.

Fibres are biodegradable natural products, and all the inputs used to produce them are either natural products themselves, such as seeds and fertilizer elements, or they are biodegradable, such as feed additives and pesticides (no pesticides any longer registered for use in modern agriculture are persistent). Natural fibre plants absorb carbon, produce oxygen, and improve soil fertility as part of crop rotations. Animal husbandry has been part of circular, sustainable agricultural systems for thousands of years.

Cotton accounts for about three-fourths of world natural fibre production. China and India each produce about 6 million tonnes, the United States about 4 million, Brazil nearly 3 million, and all other countries together about 8 million tonnes.

2021/21 (August-July) was a season of full recovery for the world cotton industry from the challenges of the previous year. World cotton consumption and trade were nearly record high in 2021/22, and the Cotlook A Index reached approximately $1.40 per pound, the highest average since 2010/11. The value of world cotton production at the farm level rose from approximately $40 billion in 2020 to nearly $70 billion in 2021.

The strength of cotton prices suggests that world cotton consumption in 2021/22 rose substantially from the 2020/21 level of 25.7 million tonnes and may have exceeded the previous record of 26.7 million tonnes set in 2007/08. In significant contrast to the situation in 2011/12, when the season average Cotlook A Index was more than $1.60 per pound and world mill use fell to 22.4 million tonnes, mill use in 2021/22 increased even though cotton prices were again far above the long run average.



World production of the JACKS fibres (jute, abaca, coir, kenaf and sisal) trended slightly downward during the last decade, from 4.8 million tonnes in 2010 to 4.6 million tonnes in 2019. There was a steep decline in production of jute, kenaf and allied fibres in 2020 due to particularly adverse weather in Bangladesh and India caused by Cyclone Amphan. Encouragingly, production rebounded, and JACKS fibre production in 2021 is estimated at nearly 5 million tonnes.

Epidemiology of *Verticillium* wilt of cotton based on monocyclic disease principles in Iran.

Dr. Morteza Arabsalmani

Assistant Professor, Cotton and Fiber Crops Research Department, Tehran Agricultural and Natural Resources Research Center, AREEO, Iran

mortezaarabsalmani@yahoo.com

Abstract

Verticillium wilt incited by *Verticillium dahliae* Kleb. is one of the most important diseases of cotton in Golestan, Fars, Mazandran and Ardebil provinces. The results showed that Verticillium wilt causes the reduction rate of seed germination, boll weight, yield, ginning turn out, weight of 1000 seeds, plant height , number of leaf, number of boll, number of node, oil percentage in wet seed, elongation, fiber fineness, length of fiber, fiber strength, fiber uniformity and decrease percentage of oil in dried seed .Correlation between percent disease with pre planting inoculum density was determined with curve $Y = 4.01x - 5.74$, ($r^2 = 0.68$) and when logarithm of non-infected plant was effected the curve changed in to: $Y=0.09x - 0.25$,($r^2 =0.59$). Forecasting of disease was determined with curve of $Y = 4.07x1 + 2.65x2 - 8.8$, ($r^2 = 0.69$)(x1 = propaguale density , x2 = percent of silt to sand and Y = percent of disease) and when logarithm of non-infected plant was effected the curve changed in to:$Y = 0.00927x1 + 0.009x2 - 0.632$, ($r^2 = 0.69$) (x1 = propagule density , x2 = percent of silt and Y = percent of disease). Only 13 - 23% of yield loss, 60 – 69% of disease percent and 60% of disease index is predictable in Golestan provience.

Key words: Cotton, verticillium wilt, infection threshold and inoculum density**.**

Introduction

Upland cotton is a major component of the current cropping system for irrigated land of the Slamic Repablic of Iran. Last decade about 100000 – 180000 hectares are sown cotton in Iran. Verticillium wilt incited by *Verticillium dahliae* Kleb. is one of the destructive diseases of cotton in Iran(Arabsalmani 1999 , Ershad 1995 and Sanei,*et al*.,2010)**.** About 10 000 - 180 000 hectares are sown annually to cotton in that region (Arabsalmani 1999). The current yield loss in the world is about 1.5 million bales. Estimates of the yearly loss in Iran from 1999 to 2004 were recorded 14.23%, 13.67%, 11.73%, 10.65% and 10.42% respectively (Arabsalmani, *et al.*, 2004). The causal agent, *Verticillium dahliae* Kleb. is a soil borne fungus and the disease is typically monocyclic based on Vanderplank's concepts (Singlton *et al.*, 1992; Cammpbell & Madden, 1990). For this reason, inoculums at planting time play a critical role in disease development.The research indicated that the occurrence and severity of the disease were significantly correlated to the inoculums density of microsclerotia in the soil (Hillocks, 1992; Mace and Bell, 1981).These microsclerotia were the main source of the pathogen for the outbreak and prevalence of Verticillium wilt of cotton.

Relationships between inoculums density in soil and incidence and severity of wilt have been studied extensively in America and other countries, but the results are very variable, because cultivars tolerance cultural practices, soil condition and soil assessment method were different (Ashworth, 1983; DeVay and Pullman, 1984; Bejarano-Alcazar, *et al*., 1995; Arabsalmani, 1999). Ashworth *et al.* (1972) reported that 100% disease incidence occurred in soil containing 3.5 or more microsclerotia per gram of soil, and disease incidence of 20-50% occurred in soil containing 0.3 – 1 microsclerotia per gram of soil by wet sieve method. Based on the work of Schnathorst and Mathre (1981), inoculum threshold that required pre planting for visible symptoms in cotton were 100 propagules per gram of soil for severe strain (T-1) and 1000 propagules in per gram of soil for moderately virulent strain (SS-4).DeVay and Pullman (1984) reported that 100% disease incidence occurred in soil containing 13 - 14 microsclerotia per gram of soil. The effect of 5, 20, 40 and 60 propagules per gram of soil initial inoculums densities of on foliar disease symptoms and disease progress with time was reported by Pullman and DeVay (1982b).An increase in inoculums density from 5 to 60 propagule per gram of soil, caused an increase in infected plant' percentage in time.Inoculum density of 5, 22 and 60 propagules per gram of soil caused 15, 50 and 95% foliar symptom, respectively. Disease incidence increased from 0 to26.9 propagules per gram of soil but yield losses was not the same ratio (Paplomatas *et al*., 1992). The life cycle *V. dahliae* can be divided in to dormant, parasitic and saprophytic stage. In addition, inoculum density in soil, disease severity and loss of wilt depend on cultivar tolerance, pathotype (defoliating and non-defoliating strain) of *V. dahliae*, soil condition especially pH, moisture content, and nutrient content, concentrations of microbial antagonists or synergists, plant density, date of planting and cultural practices (Hillockes, 1992), that total effects determined inoculum potential. The epidemic development of the disease is highly influenced by the inoculums density in the soil.

Material and Methods

A: In order to determine the effect of disease on the quantitative and qualitative characters of cotton yield, Sahel cotton cultivar were sown in natural land infestation to *V. dahlia*e which cotton was planted for 12 years continuously and percent of wilt was 95% in last year. Four months after planting based on the level of disease severity a single plants was divided into five grades: 0 grades (normal); the 1st grade (diseased leaves less than 33%); the 2nd grade (diseased leaves between 34 – 66%); the 3rd grade (diseased leaves between 66 – 99%) and 4th grade (diseased leaves between 100% or defoliating or dead plant).In each group, 100 plants were selected and evaluated for rate of seed germination, quantitative and qualitative characters of yield, and weight of 1000 seeds. Characters were evaluated using SAS software based on a completely randomized block design with five replications. The reduction characters of diseased plants in every grade with health plant were assessed.

B: During 2006 – 2009, composite soil samples were collected from April 4th to May 5th in 143 fields with area of 400$_{m2}$ in Golestan Province. A total of 143 fields were planted with commercial cotton cultivar, Sahel. Composite soil consisted of 20 – 22 samples from 5 – 30$_{cm}$ depth of soil. Cores were bulked for each plot, broken into small clumps and air- dried in the laboratory for 4 -6 week at 20 – 27 degree (Bejarano – Alcazar *et al.*, 1995; Butterfield and DeVay, 1979 and Ashworth, 1983). The soil samples were sieving with 2mm sieve and population of *V. dahlia*e was assessed based on colony forming unit (CFU) per gram of dried soil using semi selective Alcohol agar medium (Ausher *et al.*, 1972; Singlton, *et al.*, 1992 and Goud and Termorhuizen, 2003).Sample were sent to Bastam Agriculture and Natural Resources Research Center and soil characteristics such as percentage of organic matter, ECe, pH and texture were determined.Disease index (DI) belongs to fields were calculated by following formula (Chen *et al.*, 2008). $DI = \frac{\sum (Xif) \times 100}{n \sum f}$

In this formula: X defines grade value of disease severity; n defines the value of most severity and F defines plants numbers of each grade. Yield loss in the field based on reduce of boll was calculated by following formula (Arabsalmani *et al.*, 2011).

$$A \times a + B \times b + C \times c + D \times d + E \times e$$

In this formula: A defines percent of plants with 0 grade, a equal 0; B define percent of plants with 1 grade, b equal 0.15; C define percent of plants with 2 grade, c equal 0.26; D define percent of plants with 3 grade, d equal 0.70 and E denotes percent of plants with 4 grade, a equal 1.Correlations between datas were calculated using regression procedure of SPSS version17, by Enter or Stepwise methods. To be possible of forecasting of disease was determined by collected data.

C: In the single cotton field: Cotton cultivars, Varamin, Sahel, Sepid and Zeta-2 were sown in Karkandeah research station with natural infestation of *V. dahlia*e in 18, 76,76 and 76 plots for two years, respectively. Each plot consisted of 6 rows. The length of the row was 11m and plant spacing was 80 by 20 cm. At planting time, composite soil samples were collected in the plots. Composite soil samples consisted of 20 – 22 cores each 2.5 – 30cm. Cores were bulked for each plot, broken into small clumps and air-dried in the laboratory for 4 -6 weeks at 20 – 27 degree (Bejarano – Alcazar *et al.*, 1995; Butterfield and DeVay, 1979 and Ashworth, 1983). The soils were sieving with 2mm sieve and population of *V. dahlia*e was assessed based on colony forming unit per gram of dry soil by using semi selective Alcohol agar medium (Ausher *et al.*, 1972; Singlton, *et al.*, 1992 and Goud and Termorhuizen, 2003). Correlation between pre planting inoculums density and disease percent and disease index were calculated using SPSS software.

D: In the flowerpot: This study was conducted to evaluate the interaction between population density of *V. dahlia*e and varieties on the basis of split plot with 24 treatments and four replications in Karkndeh research station. Main factors were six inoculum density and sub factors were varieties. Infected soil was prepared with 0, 5.56, 11.5, 16.22, 19.2 and 23.5 propagule per gram of dry soil by this method. Soil was collected from natural infestation to *V. dahlia*e which cotton was planted for 12 years continuously and percent of wilt was 95% in last year .Sterile soil collected from desert. Infected soil combined to sterile soil in ratio of 8/8, 1/8, 4/8, 6/8, 7/8 and 8/8. Population of *V. dahlia*e based on colony forming unit per gram dry soil was assessed in each combined. Combined soil removed in flower pot with have 25_{cm} high, 30_{cm}width and 65_{cm} length .For each inoculum density of *V. dahlia*e, Varamin, Sahel, Sepid and Zeta-2 cotton cultivars, were sown in flower pot with 4 replications. Flower pots were placed in the field and protected the same as of cotton field .Data were analyzed using SAS software and Duncan's method.

Results

A: In the field:

1-Effect of verticillium wilt on agronomical characters of cotton: The results showed *Verticillium* wilt reduces the rate of seed germination, boll weight, yield, ginning turnout, weight of 1000 seeds, plant height, number of leaves, number of bolls, number of nodes, oil percentage in wet seed,elongation, fiber fineness, length of fiber, fiber strength, fiber uniformity and percentage of oil in dried seed(Table 1).

Table 1. The comparison of reduction characters of diseased plants in every grade with health plant (%).

Grade of diseased plant	Number of boll	Boll weight	Plant height (cm)	Number of leaves
0	0	0	0	0
1	-15.95	-8.07	-11.29	-19.30
2	-26.5	-9.54	-18.33	-31.04
3	-70	-13.45	-35	-80.7
4	-100	-100	-59.5	-100

2-Frequency of Verticillium wilt in field: All fields were planted with the tolerant Sahel cultivar. *V. dahlia*e was found in 94.4% soil sample fields. Population of inoculums in 143 fields ranged from 0 – 22.5 CFU per gram dried soil, with an average 7.9 CFU in per gram and 24% of field had 12 – 22.5, 26% of field had 5 – 16 and 50% of field had less than 6 CFU in per gram dried soil. Soil texture of field was Silt – loam (53%) and Sandy – loam (47%) and other soil characteristics such as pH was between 7.2 – 8.6, ECe was between.17 – 7.86 ds/m, saturated percent had between 14 – 41%. The symptom of Verticillium wilt was found in 59% fields, with ranged from 0 – 96.42% and 24% of field had more than 50% diseased plants and, 47% of field had less than 10% diseased plants .These symptom to belong defoliating and non-defoliating strains. Disease index in field ranged from 0 – 55.25, and 73% of field have less than 12.5, 14% of field have between 12.5 – 25 and 13% of field had more than 25.Yield loss in field ranged from 0 – 46.51%, and 39.4% of field not found loss due to wilt disease, 31% had less than 10%, 16%of field had between 11 -20%, 11% of field had between 21 -30% and 6% had between 31 – 46%.

3-Regression relationship between disease percent, disease index and yield losses with pre planting inoculum density by Inter method : Regression relationship between disease percent, disease index and yield losses with pre planting inoculum density were significant (p = 1%) and were determined with curves: Y = 4.01x – 5.74, (r^2 =0.68) and when logarithm of non-infected plant was effected the curve changed in to: Y=0.09x – 0.26, (r^2 =0.59).With these curves minimum number of propagules required for systemic infection in Sahel cultivar is 1.43 – 2 in per gram of dried soil and with foliar symptoms, 50%, fungal population density is 14 propagules in per gram of soil. Correlation between index of disease with pre planting inoculum density was determined with curve Y_1 = 0.07x –0.19, (r^2 =0.60)) and when logarithm of non-infected plant was effected the curve changed in to: Y1=0.02x – 0.07, (r^2=0.56). Correlation between yield loss with pre planting inoculum density was determined with curve Y_2 = 0.42x -1.8, (r^2 =0.05). , x=inoculum density, Y= disease percent, Y_1=disease index and Y_2 = yield loss. Where, using these formula, if Y = zero, resulted, x= 1.43(=2), thus, minimum number of propagules required for systemic infection in Sahel cultivar was 1.43(= 2) per gram of dried soil and if Y_2= zero, resulted , x= 4.29(=5). If fungal population density or x was 4.29 and 14 propagules per gram of soil, foliar symptoms will be 11.44(=12) and 50%.In order word if fungal population density was 4 - 5 propagules per gram of soil or percent of disease was 11-12 % , yield losses will be zero. Relationship between yield losses with disease percent was determined with curve $Y = 0.8x - 3.39$, (r^2 =0.07) and when logarithm of non-infected plant was effected the curve changed in to $Y = 4.51x - 5.97$, (r^2 =0.08). Relationship between yield losses with disease index was determined with curve $Y = 0.27x - 5.84$, (r^2 =0.19) and when logarithm of non-infected plant was effected the curve changed in to $Y = 0.24x - 4.59$, (r^2 =0.19).Based on these results the best index for yield loss evaluation after planting is disease index. Because in addition of inoculum density, on yield losses depended on texture of soils, C/N ratio, total nutrient volume and saturated percent.

4 -Regression relationship between disease percent, disease index and yield losses with pre planting inoculum density by Stepwise method:

The results showed that a low significant correlation between was found yield loss with pre planting propagule density and characters of soil. This relationship, when non infected plant were used with logarithm transformation was determined with equation,

$Y = 0.36x_1 + 0.31x_2 + 14.04x_3 + 0.06x_4 + 0.24x_5 + 0.25x_6 + 1.5$, ($r^2 = 0.25$).

If any of the variables were not available, the above curve becomes as follow:

$Y = 0.37x_1 + 0.31x_2 + 13.88x_3 + 0.06x_4 + 0.2x_5 - 3.1$, ($r^2 = 0.23$).
$Y = 0.35x_1 + 0.31x_2 + 11.08x_3 + 0.05x_4 - 5.32$, ($r^2 = 0.2$).
$Y = 0.39x_1 + 0.32x_2 + 10.96x_3 - 4.51$, ($r^2 = 0.16$).
$Y = 0.46x_1 + 0.29x_2 - 1.27$, ($r^2 = 0.11$).
$Y = 0.42x_1 - 1.8$ ($r^2 = 0.06$).
Where, x_1 = propagule density,
x_2 = ratio C/N, x_3= percent of sand to clay,
x_4= percent of N+ K/P,
x_5= soil saturation percent,
x_6= phosphor content of soil.

Correlation between yield losses with inoculum density at planting when all plants were suitable for infection was determined with this curve.

$Y = - 0.191x_1 + 0.342x_2 - 0.145x_3 + 14.5x_4 - 10.84$, ($r^2 = 0.13$).

The above curve becomes as follow if any of the variables were deleted:

$Y = 0.33x_2 - 0.138x_3 + 11.52x_4 - 2.93$, ($r^2 = 0.11$).
$Y = - 0.15x_3 + 12.8x_4 - 5.19$, ($r^2 = 0.088$).
$Y = 12.08x_4 - 1.59$, ($r^2 = 0.056$).
Where, x_1 = saturated percent,
x_2 = propagule density,
x3= ratio of K/P,
x_4= sand to clay ratio.

Because yield loss is dependent on very variant after planting such as weeds, cultural practice, date of planting, density of plant, irrigation and nutrition (El-ZiK, 1985 and Mace, *et al.,* 1981and Tjamos *et al.,* 2000).Thus , only 13 - 23% of yield loss, 60 – 69% of disease percent and 60% of disease index is predictable in Golestan provience with data of this research .Forecasting of disease percent also was determined with curve of $Y = 4.07x_1 + 2.65x_2 - 8.8$, ($r^2 = 0.69$) ($x_1$ = propagule density, x_2 = percent of silt to sand and Y = percent of disease) and when logarithm of non-infected plant was effected the curve changed in to: $Y = 0.00927x_1 + 0.009x_2 - 0.632$, ($r^2 = 0.60$) ($x_1$ = propagule density,

x_2 = percent of silt and Y = percent of disease).Forecasting of yield loss was too predictable with following curve.Y $=0.191x_1 + 0.342x_2 - 0.145x_3+14.05x_4+10.84$, ($r^2$ = 13). (X1 = propagule density, x_2 = faturated percentage, x_3= Potassium to phosphorus, x_4= percent of silt to sand and Y = yield loss).

B: In the single field: Population of *V. dahlia*e, was evaluated 27 – 30 CFU per gram dry soil in field and 70-100% disease symptom were found in different cultivars. Correlation between disease percentage and pre planting inoculums density were significant($p<1\%$) and determined with curves in Sahel cultivar, Y = 9.654x – 190.56, (r^2 =0.68 and 27 < X< 30), in Varamin cultivar Y = 7.01x – 102.4, (r^2 =0.804 and 27 < X< 29), in Sepid cultivar curve Y = 7.27x – 117.88, (r^2 =0.699 and 27 < X< 30) and in Zeta-2 cultivar Y = 7.10x – 110.186, (r^2 =0.66 and 27 < X< 29) in field. In this formula: X defines inoculums density and Y defines disease percent(table1).Based on these furmula, if inoculum density at planning time is 27 propagule per gram dry soil, disease percent of Sahel, Varamin, Sepid and Zeta 2 cultivars at the end of growing season will be 67.56, 86.87, 78.41, and 81.51% in field, respectively. Verticillium tolerance rating (VTR) of Sahel, Sepid, Zeta-2 and Varamin (check) are, 138,125,121 and 100, respectively .

C: In the flowerpot: Population of *V. dahlia*e, was evaluated 0 – 23.5 CFU per gram dry soil in micro plot. Correlation between disease percentage and pre planting inoculums density were significant($p<1\%$) and determined with curves in Sahel cultivar, Y = 4.04x – 14.10, (r^2 =0.87 and 0 < X< 23.5), in Varamin cultivar Y = 4.07x – 10.23, (r^2 =0.83 and 0 < X< 23.5), in Sepid cultivar curve Y = 4.09x – 13.36, (r^2 =0.88 and 0 < X< 23.5)and in Zeta-2 cultivar Y = 4.15x – 10.46, (r^2 =0.88 and 0 < X< 23.5) in flowerpot. In this formula: X defines inoculums density and Y defines disease percent. Based on these furmula, inoculum density at planning time for 50% infection of Sahel, Varamin, Sepid and Zeta 2 cultivars at the end of growing season were 15.86, 14.79,15.49, and 14.57 propagule per gram dry soil in micro plot, respectively.Minimum number of propagules required for systemic infection (inoculums threshold) Sahel, Varamin, Sepid and Zeta -2 cultivars were 3.56,2.52,3.27 and 2. 52 per gram of dry soil, respectively.Different cultivars had significant difference in wilt percentage and disease index. Varamin with 75.44 disease percent and 47 disease index was the first category. Sahel, Sepid and Zeta-2 cultivars with 61.98, 60.94 and 68.23 percentage of wilt and 40.5, 37.5 and 37.75 disease index were in second place .Increasing population of pathogen, from 5.56 to 23.5,increased disease percentage , disease index and the percent of earliness but yield and number of bolls and other plant characters reduced .For assessed of tolerance of mentions cultivars with inoculums density of Zero, 5.56,19.22 and 23.5 compared tolerance not suitable, because in inoculums density of Zero and 5.56,(same category) ,disease percent is insufficient and in inoculums density of 19.22 and 23.5,(same category) disease percent is very high and not significant difference in wilt percentage .In inoculums of 11 - 16 propagule per gram of dry soil is suitable for assesses of tolerance comparison of mentioned cultivars. In these inoculums density, the disease index of Sahel, Sepid, Zeta-2 and Varamin cultivars was between 23.5 to 60.75 and disease percentage between 59 to 81% respectively. Verticillium tolerance rating (VTR) of Sahel, Sepid, Zeta-2 and Varamin (check) are, 129,117,123 and 100, respectively.

Discussion

Soil conditions in Golestsn Provience are suitable for incidence of Verticillium wilt in cotton (Hillocks, 1992). Based on this study, Sahel is tolerant than Sepid, Sepid is tolerant than Zeta-2, Zeta-2 is tolerant than Varamin cultivar. Theoretically for comparing cotton varieties for tolerant to Verticillium wilt, disease index in susceptible cultivar or check should be 50%. Based on these study inoculums of *V. dahliae* for tolerance comparison of mentioned cultivars were 11 - 16 propagules per gram of dry soil and Varamin cultivar is suitable for check or susceptible cultivar. In these inoculum,if cultivar tolerant than Varamin,as a ersalt disease index more than 50 and if cultivar more than susceptible, as a resalt disease index less than 50. For management of verticillium wilt and reduce the damage due to wilt, initial population of the pathogen have not enough to causing of systemic infection or disease percent must less than of 11%. These results are useful for management of verticilium wilt of cotton based on release of tolerance of cotton. Managment of verticilium wilt of cotton based on reduce of pupulation of the caugal egent, inoculum density must less than 3.56, 2.52, 3.27 and 2. 52 per gram of dry soil, respectively if Sahel, Sepid, Zeta-2 and Varamin cultivars will be planted. The results of this study indicate that within an individual field, the incidence of Verticillium wilt resulting in plant stunting, reduce of boll number and boll weight, and these effects can be predicted based on inoculums density and soil characters at the time of planting. About 60 – 69% of disease percent of Verticillium wilt to be capable to predict with pre planting density and clay% in soil but 13% of yield loss to predictable. Minimum number of propagules required for systemic infection in Sahel cultivar is 1.43 – 2 in per gram of dried soil and with foliar symptoms 50%, fungal population density is 14 propagules in per gram of soil. Based on these data and classical formula of monocyclic disease ($Ln = [\frac{1}{1-X}] = QRt + K$) we able to peredicted of minimum of population of *V. dahliae* in field that losses due to wilt, will be zero. In this formula: X defines amount of disease index; Q, amount of population of *V. dahliae* in pre planting data; R defines efficiency of inoculums density and t defines time of assessing. For example,If :Q1= 24; X_1 = 90 ;X_1= 11 and time is four mount after planting; Q2 or pupulation of pathogen that acceptable =?

$$Q2 = \frac{2.30}{0.11689} = 2.046$$

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Production and commercialization of cotton hybrid seeds

M. Fathi Sdaabbadi[1*], *O. Alishah*[2]

1- Assistant professor, Cotton Research Institute of Iran, Agricultural Research, Education and Extension Organization (AREEO), Gorgan,Iran.
2- Professor, Cotton Research Institute of Iran, Agricultural Research, Education and Extension Organization (AREEO), Gorgan,Iran.

***Corresponding Author's Email:** mohsenfathi433@yahoo.com

Introduction:

Hybridization as a common method in preparing new improved cultivars with good quality and quantity in cotton research, like most other plants, has yielded good results. The use of heterosis, especially in the small increase of crops, has long been considered in many crops and in cotton. One of the ways to increase yield per unit area is to use heterosis and commercial production of F1 hybrid seeds. Successful hybrid seed preparation requires identifying the best combination of cultivars with the most heterosis.

In order to production and commerciali-zation of cotton hybrids, four intra and inter specific hybrids "HB-931, HB-932, HB-933 and HB-934'' were produced at Hashem-Abad and Karkandeh cotton research stations in 2017-2021. The project conducted based on applied agreement between agronomy deputy of Jihad-e-Agriculture ministry and Cotton Research Institute of Iran at Hashem-Abad and Karkandeh research stations.

Material and methods:

Sahel, Sajedi, Varamin and Bakhtegan cultivars (*G.hirsutume* L.) and T-14 (*G. barbadense* L.) were selected as parental lines. Entries were arranged in six crossing block in each location and 160 and 80 row spacing for maternal and parental lines, respectively. Intra row spacing of plants was 40 cm. The sowing date of parental lines was varied 5 to 22 May 2017 depending on location. The female and male parents are planted in the same field in separate plots in 4:2. However, the seeds of male parents were sowed one week earlier due to late maturity and with the aim of synchronizing their flowering with the female parent. Agronomic activity same as weeding, thinning, irrigation and pest management was carried out according standard methods. Hand emasculation and pollination began since 16 July till 21 August. The best time for emasculation is 3-6 PM. Emasculated buds are pollinated the next morning with the pollen of male parent. The best time for pollination is 8:00 – 11:00 AM, because the stigma receptivity is maximum during this period. Generally, 4-5 buds are pollinated by one flower of male parent.

In the manual method, cotton flowers are castrated on the mother base in the evening before opening, so-called in the candle stage (Figure 2-a), and all the flags are removed with a fingernail (Figure 2-b). Care should be taken that no anthers or feathers remain on the flower and that the ovaries and ovaries are not damaged. The stigma is covered with some cotton fiber or small paper bags to prevent unwanted pollen by the wind or insects. Opened and discolored flowers are removed from the maternal plants. The next morning, the pollen is transferred from the male parent to the castrated flowers on the maternal plants. Each male flower is enough to transfer pollen to 3-4 female flowers. After manual pollination, the stigma is covered with cotton fibers again and the peduncle is tied by thread. Final, harvesting is done from the identified open boll.

Results:

The seed cottons of F1s (HB931, HB932, HB933 and HB-934 hybrids) and self-parental lines harvested and followed by ginning process, separately. Final, 97.3 kg hybrid seed were produced and have delivered to advancement of cotton program of country.

Table 1- genotypes and hybrids studied

hybrid	Inter/intra specific	Male parent ♂	Female parent ♀
HB931	*G. hirsutum * G. hirsutum*	Sajedi	Sahel
HB932	*G. hirsutum * G. hirsutum*	T2	Bakhtegan
HB933	*G. barbadense * G. hirsutum*	T14	Varamin
HB934	*G. barbadense * G. hirsutum*	T14	Sajedi

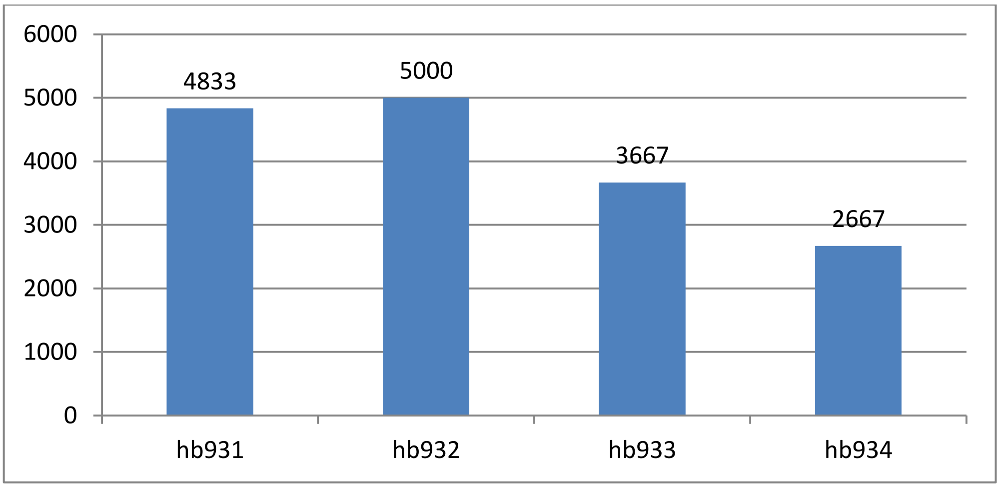

Figure 1-Comparisons yield of hybrids-2021 (kg*ha^{-1})

Advantages

- Superior yield performance coupled with superior fiber properties.
- Wider adaptability
- Good price for the produce
- Employment generation through labor intensive hybrid seed production.
- Short duration hybrids can fit into multiple cropping systems under irrigated areas.
- By inclusion of cotton in double and multiple cropping, cotton will find place in crop rotation in new areas, thus contributing to increased area under irrigated cotton without impairing the area of other crops.

a. Square Selection

b. Emasculation

c. Pollination

d. Hybrid boll

e. Hybrid farm

Figure 2- Stages of hybridization in cotton

Disadvantages

- high cost of seed,
- high cost of cultivation,
- difficulty in seed production and
- Neps and motes especially in interspecific hybrids.

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Using sulfur as a disinfecting agent for cottonseeds

Ghorban Ali Roshani[*1], Morteza Arabsalmani[2]*

1- Associated Professor, Cotton Research Institute of Iran, Agricultural Research, Education and Extension Organization (AREEO), Gorgan,Iran.
* Email of Corresponding Author: ghroshani69@gmail.com

2- Assistant professor, cotton and fiber crop research department, Tehran Agricultural and Natural Resources Research and Education Center, AREEO, Varamin, Iran

Abstract:

Seed disinfection is the coating of seeds with a substance or chemical to reduce, control, or repel insects, pathogens, and other organisms that damage the seed or plant. Fungi that are present with seeds or in the soil, cause seed rot and plant death whether in storage or on the field. Seed treatment with fungicides and insecticides is the most economical and easiest choice to reduce the damage. Up to three weeks after planting, the plants are protected, are sufficiently resistant and usually after this date are able to tolerate and compensate for the damage. Among different chemicals the sulfur due to its fungicidal, insecticidal properties, cheapness, ease of storage and consumption, low toxicity to humans and other mammals and providing part of the plant's nutritional needs is one of the most suitable compounds for disinfecting cottonseeds. In case of disinfection of cottonseeds with sulfur, storage pests are also being controlled and the remaining seeds can be used to feed livestock after washing.

Keywords: cottonseed, disinfection, sulfur, plant death and seed rot.

Introduction:

Damaging seed and plant causes a decrease in the number of plants per field and indirect losses include tillage costs, non-uniformity in the field, late crop and increased production costs. If the plants are protected within two to three weeks after the planting, they will usually be sufficiently resistant to attack by the plant's harmful agents after this date. Butterfly moths, herbivorous flies, bean flies, jasmine rootworm, crown worm and cotton trips are the most abundant pests, that cause damage on seeds and plants in the field. Yellow cotton trips (*Trips tabaci*) is the most important pest of the first season in most cotton growing areas of Iran.

Figure 1: Plant stagnation due to agrotis feeding

Sulfur is an element that is present in nature in large quantities in the free state or in combination with other elements. Sulfur is mined in elemental form of sulfide and sulfate. Often in the form of pure chemical crystals or with gypsum and Limestone is mixed. Sulfur alone and in combination with California solution is one of the most important fungicides. In 1800 and early 1900, sulfur dust was used against powdery mildew on fruit trees, especially grapes, and in 1958 it was the most common fungicide. Water-soluble sulfur controls fungal diseases, worms and mites on plants. It is also used to lower the pH and increased the acidify of the soil.

Micronized Sulfur is not suspended in water, but water-soluble sulfur could mix with water to produce a uniform liquid. Water-soluble sulfur is compatible with nicotine sulfate and is also used in spraying. Micronized sulfur is made by special chemical processes, in this process sulfur is converted into fine particles. The particle diameter is about 6-8 microns and about 95% of purity. Micronized sulfur is used in powder or liquid form against pathogenic fungi. This type of formulation has insecticidal properties and can be mixed with water and has the greatest effect at 22 ^{oC}. Micronized sulfur should not be used at temperatures above 27 ^{oC}. Water-suspended sulfur is a very soft powder mixed with wetting and dispersing agents. It is possible to mix water-suspended sulfur with most pesticide compounds except oils. Colloidal sulfur particles are produced by conventional milling processes. The diameter of colloidal sulfur particles is about 50 microns. It is produced by acidifying the California solution or similar reactions of colloidal sulfur. Micronized Sulfur is a yellow powder consisting of fine angled crystals. Water-suspended sulfur has very fine particles that are formulated in aqueous form. The thickness of the particles is not more than 5 microns. Sulfur dust is not mixed with water and is used as a dry powder. California solution or lime sulfur is a mixture of calcium polysulfide and calcium thiosulfate. This solution is produced by combining lime with sulfur. Today it is used to control a variety of diseases such as Roses black spot and raspberry diseases.

Benefits of using sulfur

Sulfur has been used to disinfect homes and warehouses since thousands of years BC. Sulfur is important in the management of fungal pathogens and the control of mites and is used to control many plant diseases. Among the mineral fungicide compounds, sulfur is the first very effective fungicide in controlling plant diseases, the use of which dates back to several centuries ago. The fungicidal properties of pure sulfur were known at least 533 years ago. A number of pure sulfur mineral compounds have fungicidal and even insecticidal properties.

Sulfur is a non-systemic fungicide with protective-healing properties, which acts as a protective fungicide to prevent spore germination. In India, sulfur is used in large quantities every year to produce fungicides. Fortunately, unlike systemic toxins, resistance to this compound has not been observed, especially in fungi. The importance of disinfection with micronized sulfur and sulfur compounds produced domestically is determined when the economic aspect of disease and pest management is also considered, because micronized sulfur is produced in abundance and at a relatively cheap price in the country and is available. is. On the other hand, this compound also has insecticide (trips control) and acaricides properties and it may be possible to replace pesticides, and thus simply by treating the seeds with a chemical compound produced in the country, in addition to acceptable control of pests and pathogens during seed storage as well as on the farm also reduced production costs.

Considering the fact that sulfur itself is a kind of nutritional element required by the plant, so the use of this compound can eliminate the need for sulfur fertilizers in the early stages of plant growth. On the other hand, the use of micronized sulfur is easier compared to other compounds and imposes the least amount of damage and pollution to the environment. This compound has very low toxicity to humans and other mammals, and if some of the treated seeds are not used for planting after storage, wash the seeds with water to remove the remaining micronized sulfur and makes it usable by livestock. As above stated, the use of sulfur has certain advantages over other fungicides that have not been found in any of the new chemical compounds alone.

Application and consumption of sulfur in cotton cultivation

A: Seed disinfection:

The amount of sulfur consumption ration is four to six per thousand kg of seeds. If the amount of seed is less than one thousand kilograms, the amount of the mentioned substances will be reduced in the same proportion. First, mix the seeds with a little moist water and then micronized sulfur or other toxins so that the surface of the seed is covered with micronized sulfur. Sulfur can be used alone or with imidaclopride (Gachu) or thiodicarb (Larvin). These toxins are recommended in 5 to 7 kg for 1000 kg of seeds.

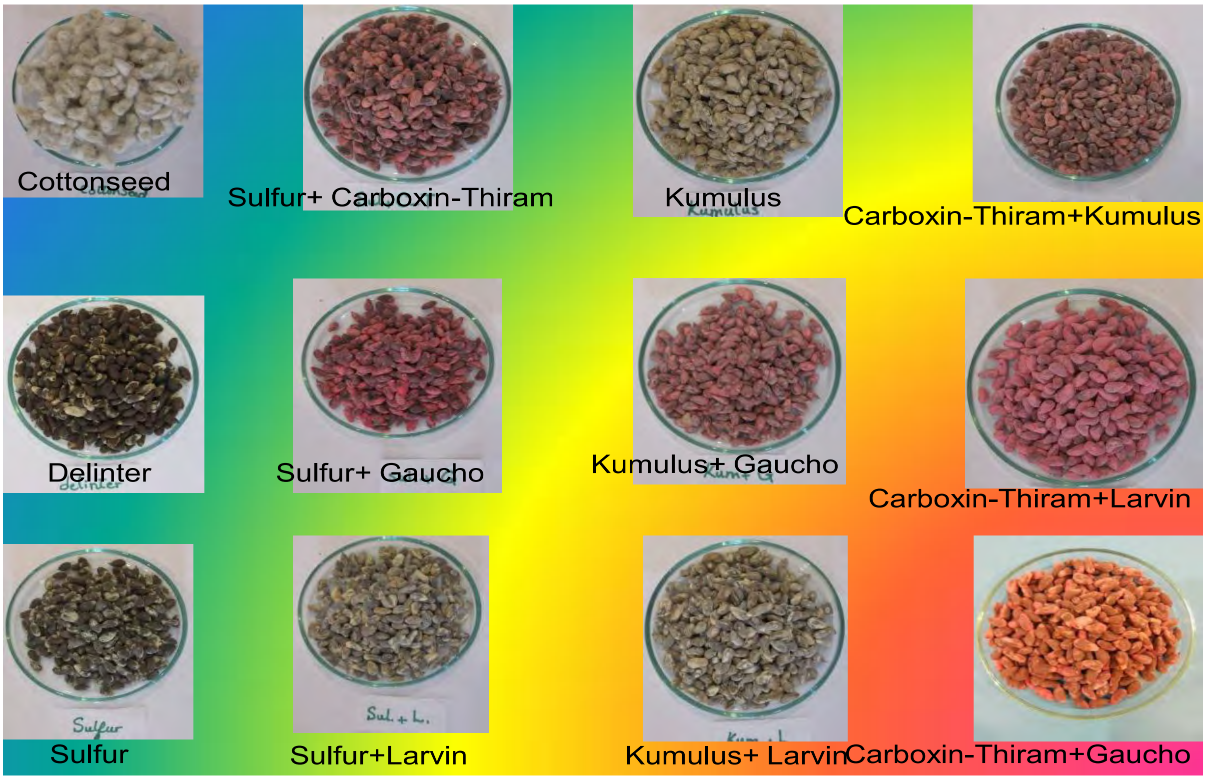

Figure 2: Seeds disinfected with various toxins

B: In the form of spraying:

Micronized Sulfur can be used in the form of spraying in the cotton fields. In this case, the population of trips, mites, snails and bollworms will be reduced and the growth of fungi (saprophytes) at the end of the season is limited and the color of the fibers is seen brighter. The amount and time of consumption is written in Table 2.

Table 1: Dosage of sulfur compounds for seed disinfection alone or in combination with larvin and gacho

	Dosage ratio (kg/1000 liter water)	Traditional name	Common contents
1	4-6	Micronized Sulfur	Micronized Sulfur
2	4-6	Kumulus	Micronized Sulfur suspended in water
3	4-6	Micronized Sulfur + Larvin	Micronized Sulfur and thiodicarb
4	4-6	Micronized Sulfur+ Gaucho	Micronized Sulfur and imidacloprid
5	4-6	Kumulus+ Larvin	Cumulus and thiodicarb
6	4-6	Kumulus+ Gaucho	Cumulus and imidacloprid

Table 2: Amount and time of consumption of micronized sulfur for spraying

	Consumption time	Consumption rate (kg per hectare)	Affected on
1	6 to 8 leaves	5-6	Trips
2	Early flowering	7-8	Trips and Bug
3	Mid-flowering	10-12	Bug and mites
4	Late flowering	15-20	Mites, bollworm, white fly and fumagine

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Water Stress Memory as a compensation reaction in seeds of cotton (*Gossypium hirsutum* L.) in expose to subsequent water deficiency

Elham Faghani[1*], Mohammad Hossein Razzaghi[2] and Mohammad habibi[3]

[1] Assistant Professor, Agronomy Department, Cotton Research Institute, Agricultural Research, Education and Extension Organization (AREEO), Gorgan, Iran. *Email: elhamfaghanibio@gmail.com

[2]Agricultural Engineering Department, Golestan Agriculture and Natural Resources Research and Education Center, Agricultural Research, Education and Extension Organization (AREEO), Gorgan, Iran.

[3] Education of Golestan province

Introduction:

Plants can *sense* and react to signals from the *environmental* conditions. The recent strides in plant biology advancement have appeared that plants have reaction mechanisms and defense programs in exposed to environmental stress that are unique, likely it related to the evolutionary acclimation of a stationary life. Thus, modern plant physiologists have focused on plant behavior, learning, and memory. It is controversial that do plants exhibit some type of behavior that indicates memory? (Wojtyla et al., 2020). Drought is an abiotic stress that severely prevents crop production of cotton (*Gossypium hirsutum* L.) grown in rain-fed farms of Iran (Zare et al., 2014). *Plant stress "memory" happens at subsequent exposures of plants against stress which makes them more tolerant to future exposure (Tombesi et al., 2018). The main cultivated cotton plant regions were the moderate climate in the north of Iran, but these days, the cotton planted area has decreased (Kolahi et al., 2021).* So, cotton cultivation has moved to dryland (Faghani et al., 2018). Plants often remember abiotic stress that they have faced during the *phonological growth stages* to harvest time, *plant reactions* and *plants' potential* refers to plant memory (Wojtyla et al., 2020). Although these physiological responses for controlling the effects of environmental stress are temporary, when stress is being for long-term, physiological changes will be stable and plants memorize past stress events, and they transfer this information to the following generations as a stress memory (Sun et al., 2021). Then, understanding cotton physiological reactions to reproduce seed for *dryland,* needs *management* practices to attain potential yield and drought tolerant seed. Severity water scarcity by the store of such compounds as abscisic acid (ABA), as a fundamental hormonal signal and *enzymatic* adjustment in double-stressed reaction was reduced. In metabolic adjustment status exposure to water-stress consecutively, ABA induce starch mobilization, which is an essential signal for metabolic adjustment against stress (Kempa et al., 2008). Moreover, ABA mainly acts in cotton seed after ripening. So, ABA plays an important role in seed germination and dormancy (Wang et al., 2019). Then, it declines the damage effects to seed germination against abiotic stress by changing ABA regulation and accumulation of calcium (Ca) as a secondary messenger (Nayyar & Kushal, 2002).

Plant material and experiment

Figure 1 shows the diagram that summarizes three years of research. Field experiments were carried out at Hashemabad cotton research station. This station site is at the south-east corner of the Caspian Sea (36° 51' N latitude, 54° 16' E longitude, and 13.3-meter height from sea level) (Figure 2). The soil texture was sandy clay silt (6, 6.8, 3) throughout the 0.5m soil profile. Water content at field capacity and wilting point were 28.1% and 14.1% by soil volume. All experiments were arranged in figure 3.

Crop Season (First Year)

Planted certified seed (same for all irigation treatments)	Irrigation treatments (W_0 to W_3)

Generated seed in W_0 tratment named S_{11}*, ….. , Generated seed in W_3 treatment named S_{14}

Crop Season (Second Year)

Seeds of first year (S_{11} to S_{14})+ certified seed (S_{10})	Irrigation treatment (W_0 to W_3)

Generated seed in W_0 tratment named S_{21}*, ….. , Generated seed in W_3 treatment named S_{24}

Crop Season (Third Year)

Seed of second year (S_{21} to S_{24}) + certified Seed (S_{20})	Irrigation treatment (W_0 to W_3)

Generated seed in W_0 tratment named S_{31}*, ….. , Generated seed in W_3 tratment named S_{34}

Figure 1) Diagram of conducting three years of research [* S_{11} means S (Seeds), the first number (1) used for first generation, and the second number (1) Used for the plot in which seed generated (first irrigation treatment or W_1)].

Figure 2) Cotton seed reproduction in exposed to third subsequent water deficiency A) (S_{24}&W_3) and B (S_{23}&W_2).

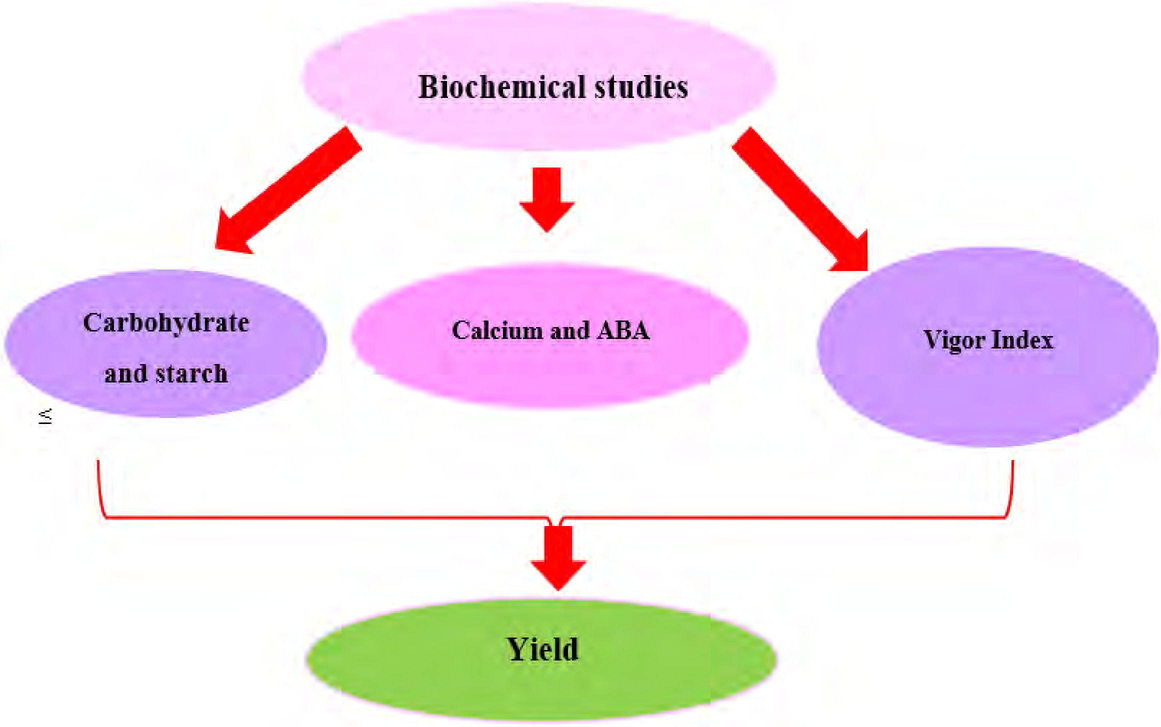

Figure 3) Diagram of all traits that were analyzed to evaluate memorial reactions in exposed to subsequent water deficiency.

Table 1: Irrigation treatments [W_0; Rain-fed (without irrigation); W_1 (33% FC); W_2 (66% FC) and W_3 (100% FC)] and seed sources [(registered seeds); (S_{21}&W_0); (S_{22}&W_1); (S_{23}&W_2); and (S_{24}&W_3) were labeled as S_{30}, S_{31}, S_{32}, S_{33}, and S_{34} effects on ABA content, thirty boll weight and yield reactions in exposed to subsequent water deficiency.

WS	ABA (ng/gFW)	Thirty-Boll Weight (First harvest) (g/m^2)	Yield (First harvest) (g/m^2)	Seedling Vigor (Index)
W_0S_{30}	25.65±3.4efg	37.3 ±5.68 c-h	18.4 ± 2.00 h	150 ±1.62 i-l
W_0S_{31}	34.25±1.3bcde	44.7 ±1.9 a-f	14 ± 7.1 h	164 ±3.25 e-g
W_0S_{32}	19.4±0.8g	45.44 ±0.61 a-e	72.43 ± 26.09gh	154 ±1.62 g-j
W_0S_{33}	31.15±1.4bcde	34.7 ±8.9 f-h	42 ± 22.24gh	158 ±1.62 f-i
W_0S_{34}	46.4±1.6a	40.6 ±7.4 c-h	66.1 ± 25.32gh	146 ±1.62 j-m
W_1S_{30}	36.05±5.1bcd	48.15 ±2.4 a-d	175.33 ± 28.84 d-g	160 ±3.25 e-i
W_1S_{31}	24.15±2.05fg	50.33 ±1.34 a-c	86.76 ± 57.44gh	162 ±4.87 e-h
W_1S_{32}	41.8±1.2ab	54.6 ±2.08 a	432.33 ± 11.31 ab	176 ±3.25 b-d
W_1S_{33}	28.65±4.1c-g	43.77 ±6.3 b-f	239 ± 39.88 d-f	152 ±0.0 k-j
W_1S_{34}	38.15±3.1a-c	51.59 ±0.8 ab	262.9 ± 34.72 de	138 ±1.62 m

WS	ABA (ng/gFW)	Thirty-Boll Weight (First harvest) (g/m^2)	Yield (First harvest) (g/m^2)	Seedling Vigor (Index)
W_2S_{30}	23.55±1.7fg	47.77 ±1.35 a-d	406.4 ± 64.01 a-c	138 ± 4.87 m
W_2S_{31}	30.95±4.4c-f	43 ±0.66 b-h	436 ± 27.23 ab	178 ±1.62bc
W_2S_{32}	36±3.9bcd	49.89 ±1.09 a-c	527.1 ± 31.89 a	162 ±4.87 e-h
W_2S_{33}	27.35±4.4d-g	42.22 ±1.94 b-h	304.23 ± 27.42 b-d	192 ±3.25 a
W_2S_{34}	37.95±5.6a-c	42.6 ±1.92 b-h	498.6 ± 24.17 a	170 ±4.87 c-e
W_3S_{30}	20.11±0.23g	38.47 ±1.38 d- h	282 ± 45.57 cd	166 ±1.62 d-f
W_3S_{31}	37.9±3.9a-c	33.25 ±0.82 h	133.1 ± 13.98 d-h	142 ±1.62 k-l
W_3S_{32}	26.65±0.26efg	33.71 ±0.31gh	86.7 ± 11.57 f-h	140 ±0.0 ml
W_3S_{33}	31.1±6.6c-g	39.22 ±0.86 d-h	232.9 ± 36.36 d-f	182 ±1.62 ab
W_3S_{34}	24.85 ±1.9efg	37.59 ±3.54 e-h	290.66± 14.54 cd	166 ±1.62df

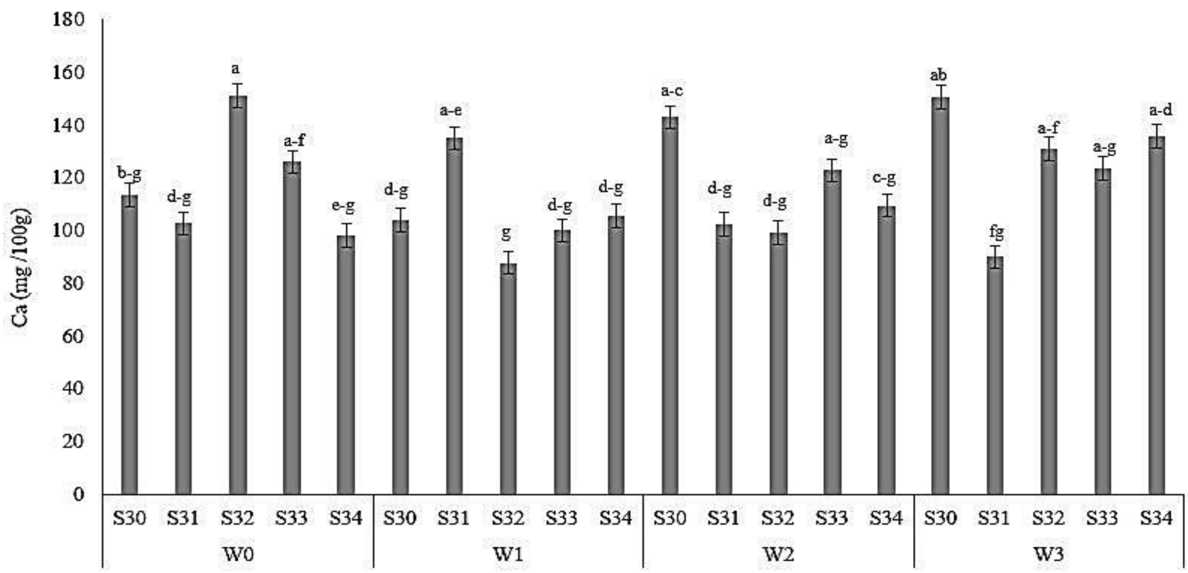

Figure 4) Calcium content trend in cotton seed under different irrigation treatments [W_0; Rain-fed (without irrigation); W_1 (33% FC); W_2 (66% FC) and W_3 (100% FC)] and seed sources [(registered seeds); (S_{21}&W_0); (S_{22}&W_1); (S_{23}&W_2); and (S_{24}&W_3) were labeled as S_{30}, S_{31}, S_{32}, S_{33}, and S_{34} in the third subsequent water stress exposure.

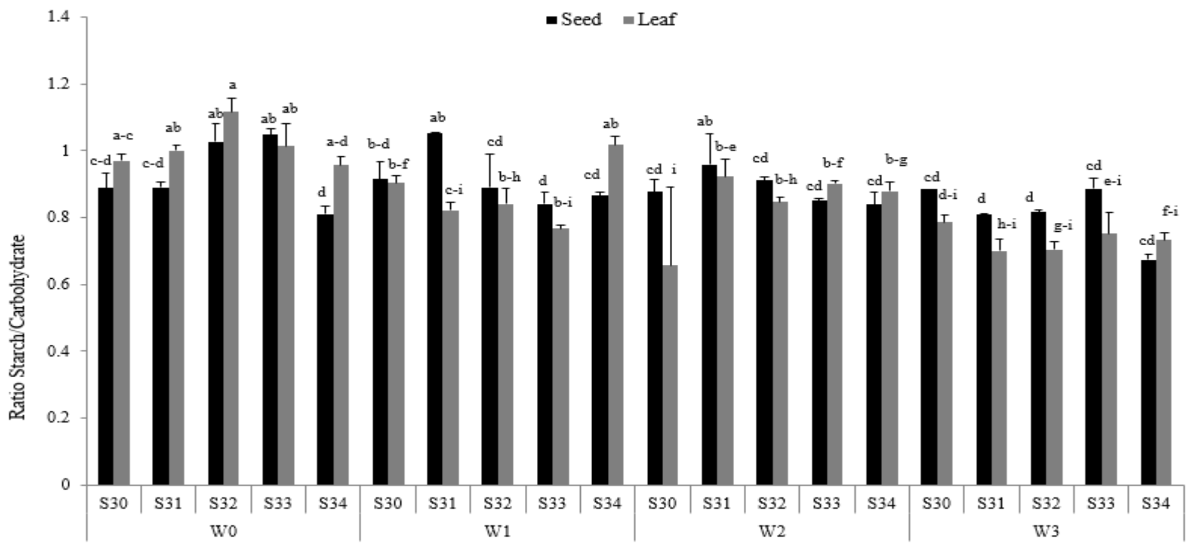

Figure 5) Ratio Starch/Carbohydrate trend in cotton seed and different irrigation treatments [W_0; Rain-fed (without irrigation); W_1 (33% FC); W_2 (66% FC) and W_3 (100% FC)] and seed sources [(registered seeds); (S_{21}&W_0); (S_{22}&W_1); (S_{23}&W_2); and (S_{24}&W_3) were labeled as S_{30}, S_{31}, S_{32}, S_{33}, and S_{34} in the third water stress exposure.

Remarks:

All remarkable information are represented in Figure 4 and 5 and table 1. ABA data showed that the selection of rain-fed and 100% FC farms for seed reproduction was not suitable since the seeds had high ABA level and represented drought signal. It seems that high ABA storage in seeds would affect seed viability. Then, the seeds, which were reproduced in exposure to one-third and full-irrigation needs could remember water deficient stress by having more ABA and low Ca content compared to other seed treatments, which may have weak germination for the next crop season. It is clear that, ABA storage in seed reproduction of S_{32} in 33% FC water need exposure was not enough to prevent seed germination in the next crop season. Moreover, the leaves of S_{30} under the rain-fed condition, 33% and 66% FC irrigation treatments, react to water-stress conditions as a result of increasing high starch in exposure to the triple water-stress. Furthermore, an increase in starch content in seed was introduced as a tolerant mechanism. Therefore, S_{22} and S_{32}, through starch storage in seed, stand against water deficiency. As other results showed, alteration in carbohydrate content caused pod absorption. This result represented that seeds of S_{32} could activate memory drought-tolerant stress for planting against 33% FC irrigation. The cotton yield will suffer serious irreversible damage when seeds are exposed to a range of intolerable water shortages. As our reports showed, the thirty-boll weight and yield decreased under drought, generally. Nevertheless, thirty-boll weight and thirty-fiber weight, at the first harvesting period enhanced in S_{32} when exposed to rain-fed, 33%, and 66% FC compared to 100% FC. Generally, the intensity of the compensation aspects was various in different seed reproduction conditions. Generally, by activating memorial stress mechanisms in plants, reproduction cotton seed in exposed to semi water shortage conditions cause plant tolerance for rain-fed farms to improve.

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