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The Three Mistakes in Cotton's Life

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Are there just three mistakes? Certainly not! How many I don't know, but in my perception this list of three is a recipe for disaster. You may not agree with me. Many may even strongly feel that this list of three actually holds the secret for successful cotton farming in India. But, discuss, we must, and argue, we will. This is an attempt to highlight at least three commonly known factors, which I am referring to, as mistakes, primarily with an intention to trigger a new way of thinking that may find new remedies. I must mention here that amongst the three mistakes the first one 'long duration varieties' is the actual monster and other two nurture the devil.

EXPERT's Column

Dr K.R. Kranthi

The three mistakes in tandem

1. Long duration varieties
2. Excess urea
3. Early use of systemic insecticides

Long Duration Varieties: The average crop duration in India is 210 days, which is about 30-50 days more than other major cotton growing countries. Long duration varieties (210-240 days) suffer from two major disadvantages. 1. The crop suffers moisture stress during boll formation and 2. The crop has a long vulnerable flowering window that invites bollworms. The long duration varieties also have excess foliage that serves as an excellent host for the sap-sucking insects. Cotton crop needs about 2 mm water and 0.5 to 1.0 kg/ha Nitrogen per day during vegetative phase and needs about 6-7mm water and 3-4 Kg/ha Nitrogen per day during flowering and boll formation stage. Thus longer the duration of fruiting phase, more is the demand for water and nutrients. In rain-fed regions of central India, when the crop is sown in July, flowering and boll formation stage in late duration varieties extends from mid-September to the end of November and sometimes even into December. Water and nutrient requirement is most crucial during this period. Nutrient uptake depends on the availability of soil moisture. In rain-fed regions of central India, rains recede by the second week of September and the soil becomes almost dry, especially in shallow soils, by the beginning of October. The crop suffers moisture and nutrient stress all through October and November and does not retain bolls properly. The long 60-80 day flowering period from September to mid-November also invites bollworm moths continuously. Indeterminate varieties have excessive foliage all through until harvest. Sap sucking pests which are generally limited to early vegetative phase, continue into the flowering and fruiting phase if the crop continues to put forth fresh leaves, as it happens with indeterminate long duration varieties. Farmers are forced to spray insecticides all through the season. No other country has had to suffer insecticides in cotton as much as India did. Clearly this happened due to India choosing long duration varieties and farmers having to use more fertilizers and also spraying 14-28 applications per season.

All cotton hybrid varieties in India are of indeterminate habit with a long duration that extends from 6 to 8 months at least. Hybrids inherently are endowed with hybrid vigour which makes them grow in a prolific manner during the vegetative phase, which makes them respond to fertilizers and water to put forth luxuriant and excessive foliage. This generally results in wastage of nutrients. This is also one of the reasons as to why cotton hybrids in India are planted at only 4000 to 6000 plants per acre. The plant density in major cotton growing countries across the world is 40,000 to 60,000 plants per acre. Hybrid cotton seed is very expensive at Rs. 0.15 per seed and is therefore planted at the low density. Because of the low plant density, each plant is expected to produce a large number of bolls per plant as opposed to a few number of bolls per plant in other countries. For example, each plant in India has to produce 100 bolls of 4g each to produce 1600 kg seed-cotton from 4000 plants in one acre. Whereas, in other countries where the plant density is 10 times higher at 40,000 plants per acre, each plant is expected to produce only 10 bolls of 4g each for a similar production of 1600 kg seed-cotton per acre. Plants in such systems take a short time of 15-20 days to complete flowering that is adequate to produce 8-10 bolls per plant. Thus the flowering phase is short and reduces the challenge of insect pests. The flowering in India is at least of 60-80 days duration which is in contrast to a much shorter flowering period in other countries. The short duration in other parts of the world has enabled countries to achieve higher per day productivity. They produce more cotton in a short time with less pest problems, due to a short flowering window and less need for fertilizers and water in a short reproductive window. There is no doubt that the long duration of cotton in India has

resulted in moisture and nutrient stress, more insect pests, diseases, need for more insecticides and low yields.

It is interesting that irrespective of India's low average national yields, many experts still believe that long duration varieties are best for India. The theory was that, if the early fruiting parts were damaged by bollworms, the crop would recover to produce new flush and thus continue to produce in an indeterminate manner, thus enabling risk aversion. The duration of such varieties extends beyond six months and can go on and on, even up to a full year, especially if water and nutrients are made available. In line with this theory, almost all the varieties developed in India were designed to be indeterminate. Needless to mention, cotton is basically an indeterminate crop. It has a perennial habit and many varieties can grow like trees, if left to survive. However in stark contrast, almost all the major cotton growing countries of the world, developed short duration varieties of 150-180 days, with determinate habit of synchronous boll formation especially to suit machine picking. Experts in India also believe that drip irrigation can solve India's problem of low yields, not just in rain-fed regions, but also in irrigated states of north India. Undoubtedly, drip irrigation saves water and fertilizers, in addition to enabling controlled application of water and fertilizers as and when needed by the plant. However, drip irrigation systems are expensive despite subsidies and need maintenance. How well these systems suit the marginal rainfed conditions of Vidarbha and Telangana is a matter of debate. Experts agree that countries which are harvesting 3-4 times higher yield than India have achieved high productivity levels not necessarily by using drip irrigation in their countries. The main technology that they have adapted to get high yields is 'Adjust Cotton Flowering Window to Fit into the Soil Moisture Regimen'.

Beyond doubt, India MUST develop short duration cotton varieties of 150-160 days duration, with synchronous boll formation of 8-10 bolls. Such varieties, if sown at a density of 40,000 to 50,000 plants per acre, earliest with the onset of monsoon in central India, can complete the short flowering and boll formation window for 8-10 bolls within a short span of time, before soil moisture become limiting, with the least requirement of water, nutrients and insecticides.

Urea Delays Flowering and Invites Insect Pests and Diseases: A sequence of events happen with urea application that actually push the crop into a problem that is not easily realised by farmers. When applied at the initial reproductive stage of 45-60 days after sowing, urea switches off the reproductive phase, triggers excessive foliage, delays flowering, delays crop maturity and makes the crop conducive to sap sucking insects. These effects get aggravated when the crop suffers from deficiency of phosphorus (P) and potash (K). Studies across the globe clearly show that the uptake of water and nutrients in cotton plants is highest at 90-110 days after sowing, which is generally the peak boll formation stage. However in India, almost all fertilizer recommendations for cotton make a mention that at sowing time or at 20-25 days after sowing, half the recommended N+K and full dose of P2O5 should be applied as basal dose followed by application of the remaining half N+K at 45-60 days after sowing. About 5 tonnes of farm yard manure or 1.0 ton of compost per acre is recommended at sowing time. Since urea is heavily subsidised, it is cheaper and farmers use it extensively. There is a misconception in India, especially in north India that a lush green cotton crop at vegetative phase will produce high yields.

Application of excessive urea at the peak vegetative stage of 45-60 days after sowing, forces the crop to become lush green with excessive foliage. Under normal circumstances, a majority of the varieties or hybrids start producing squares from 45-60 days. This first part of the reproductive phase is disrupted due to urea application. With urea, the plants switch off 'squaring-flowering' and return back to the leafy vegetative phase. This delays flowering and maturity by at least 15-20 days. Phosphorus deficiency also causes delayed flowering and maturity. A combination of more urea and less phosphorus can result in a prolonged vegetative phase and delay in the initiation of squaring and flowering window. Further, urea application in a crop that suffers from deficiency of potash invites sap sucking pests such as leaf hoppers, thrips, whiteflies and aphids. Also, there are a few diseases that get triggered with urea application. With urea induced vegetation, sap sucking pests proliferate more rapidly in varieties / hybrids that are susceptible to sucking pests.

Many Systemic Insecticides Induce Crop Vegetative Phase and Delay Flowering: Insecticides that are absorbed by the plant and translocated to other parts of the plant are known as 'systemic insecticides'. Majority of the insecticides belonging to the organophosphate group, for example monocrotophos and acephate and the neonicotinoid group of insecticides, are systemic in nature and induce the crop towards the vegetative phase. Insecticides belonging to the 'organophosphate' group and the 'neonicotinoid' group are the ones that are recommended mainly for the control of sap sucking insect pests. Sap sucking pests occur in the early vegetative phase of the crop especially in varieties or hybrids that are susceptible. As mentioned earlier, urea application in 45-60 days

old crop triggers vegetative phase, delays flowering and invites sap sucking insects. Spraying some of the systemic insecticides during the early crop stage further induce 'vegetative leafy phase' and delay flowering and crop maturity. Early application of some insecticides induces insect pest outbreaks and necessitates repeated application of systemic insecticides for pest control, which further delays the flowering phase and crop maturity.

There are three ways in which some insecticides and tank mixes can cause insect pest resurgence. 1. Broad spectrum insecticides and mixtures kill naturally occurring biological control of insect pests. 2. Insecticide induced vegetative phase and physiological changes in plants that suit insect pests 3. Insecticide induced physiological changes 'hormoligosis' in surviving insects which lay fertile eggs in excess. Nature is endowed with many insect species that are known as parasites, parasitoids and predators which kill insects that feed on the crop. These insects are useful to the farmer and are generally referred to as 'natural enemies' or 'naturally occurring biological control'. Except a few insect growth regulators (IGR), botanical pesticides and biological insecticides, majority of the synthetic insecticides have a broad spectrum toxic action on naturally occurring biological control in fields. Some insecticides have a mild effect on natural enemies whereas a few have very strong effects. Insecticide tank mixes can have devastating effects on natural enemies that can easily result in insect pest resurgence. When natural enemies are destroyed by the insecticide and if the populations do not revive, insect pests get an advantage of easy survival, which results in insect pest resurgence. There are cases where a few insecticides alter the physiology of plants, which suits some insect species thus resulting in pest outbreaks. Yet another mechanism known as 'insecticide induced hormoligosis' also can result in insect pest outbreaks. Hormoligosis is a phenomenon whereby some insecticides cause physiological changes in surviving insects to an extent that the survivors lay fertile eggs in excess which leads to outbreaks. Application of broad spectrum systemic organophosphate and neonicotinoid insecticides to control the resurgent insect pests further delays flowering and crop maturity.

Conclusion : Cotton crop benefits most when it can take up nutrients at flowering and peak boll formation stage. Nutrient uptake happens only if the soil contains adequate moisture at the flowering and peak boll formation stage. In rainfed regions of Vidarbha and Telangana, soil moisture is generally available until end of September or mid October depending on the soil type. Deep black cotton soils retain more moisture compared to shallow soils. Therefore in these rainfed regions, flowering in August and boll formation in September to mid October can help the crop to take up nutrients when applied, thereby leading to good boll setting, good retention and good yields. If the flowering gets delayed and happens over a long window that is spread over 50-80 days during September to November, boll formation gets further spread over during October to December. Flowers and bolls that form after mid-October suffer moisture and nutrient stress thus resulting in poor boll setting and low yields. Therefore any decisions and interventions that lead towards late flowering and late boll setting in cotton are to be considered as mistakes.

The first mistake is the choice of a system that aims at achieving more bolls per plant. More bolls per plant, means longer time of flowering and boll setting and long duration. The second mistake is the application of urea without adequate P and K. This intervention delays flowering further and extends the reproductive phase further into a weak soil moisture phase. Application of urea during the early squaring phase also invites sap-sucking insect pests. The third mistake is the sprays of systemic organophosphates and neonicotinoid insecticides which induce leaves, further delay flowering and in some cases, trigger insect pest resurgence thus necessitating more sprays and more delay in flowering and boll setting.

Therefore the keys to the success of cotton cultivation in the dry rainfed regions of Vidarbha and Telangana are:

1. Early sowing of early maturing varieties in June.
2. High density planting at 44,000 plants per acre with a target of 8-10 bolls per plant for an early narrow flowering window.
3. Intercropping with nitrogen fixing short duration legume crops such as green gram or black gram or cow pea or soybean. Legume crops fix nitrogen and support integrated pest management.
4. Application of balanced nutrients at peak flowering and boll setting stage.
5. Careful choice of ecologically acceptable pest management interventions mostly with bio-pesticides to ensure that the crop reproductive phase is uninterrupted and that the natural enemies are least disrupted.

Thus a narrow short flowering window of 15-20 days in August can help the squares and flowers to escape American bollworm that generally starts in September and also crop harvest before November helps the crop escape pink bollworm which starts in mid-November.

(The views expressed in this column are of the author and not that of Cotton Association of India)