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Effect of Application of Micronutrients on Spotted Bollworm *Earias vittella* (Fabricius), Infestation and Yield Components in Cotton Crop

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Abstract: Studies were carried out on the effect of micronutrients on spotted bollworm, *Earias vittella* F. infestation and yield components in cotton crop under field conditions. Cotton variety (CRIS-134) was sown in randomized block design with seven treatments including control (check) and was replicated three times on May 22, 2004-2005. Three micronutrients Bonus®, Dawn ®and Power® were applied three times at 79, 95 and 109 days after sowing. The results indicated that there was no significant effect of removal of leaves and fruiting bodies on infestation of bollworm. However, application of micronutrients significantly affected the bollworm infestation. There was significant effect of micro-nutrients on boll volume and opening of bolls in different micronutrients applied plots. The maximum yield was obtained from Bonus® applied plots than other micronutrients applied plots.

Keywords: Micronutrients, *Earias vittella* (F.) infestation, Cotton variety CRIS-134.

INTRODUCTION

Cotton (*Gossipium hirsutum* F.) the queen of fiber is the leading fiber crop of the world is grown over an area of 34.2 million hectares with a production of 25.3 million tonnes and productivity of 733 kg per hectare [1]. It is produced in more than 100 countries, the most important countries being: China (24% of global cotton production), the USA (19%), India (16%), Pakistan (10%), Brazil (5%), and Uzbekistan (4%) [2]. It is also the most important cash crop of Pakistan. It provides raw material not only to our ginning factories, and rapidly expanding textile industry but also to oil mills for making edible oil. Cotton plays significance role in the economy of Pakistan and its importance can hardly be over emphasized. The export of cotton, it's by-products and finished good provide approximately 55% of the total foreign exchange earnings of the country. It also provides employment to more than one million people. Both, its quantity and quality are equally important to meet our domestic as well as export requirements. The area cultivated under cotton in Pakistan in the year 2013-2014 was 2806 thousand hectares with a production of 12.8 million bales. The average yield of cotton in Pakistan is 815kg/ha [3]. Pakistan ranked 4th in area and production of cotton in the world, but 10th in yield per hectare [4]. Cotton not only meets the needs of fiber of the local industry but also provides food in the form of edible oil and feed in the form of seed cake. It is one of the main sources of foreign exchange earnings and brings about 60% of the foreign exchange annually from the export of raw material as well as its finished products [5].

Yield is an outcome of genotype interaction with the environment. All cotton varieties always have a huge genetic potential exploitable under optimal growing conditions. Growing conditions include climate and input applications. Since the use of agrochemicals became popular in agriculture, technological innovations for best utilization of inputs have become of critical importance for realization of optimum yields.

The deficiency of micronutrients (sulphur, iron and zinc) is wide spread in many parts of the country due to cultivation of high yielding varieties, intensive agriculture and increased use of sulphur free fertilizers in large quantities with continuous decrease in the use of organic manures, which necessitates the rational application of these elements as they have becoming limiting factors for obtaining higher yields of several crops. Sulphur shortage often impedes protein synthesis leading to accumulation of soluble nitrogen compounds. These compounds cause leaf crinkling and other morphological abnormalities [6]. In several plants species the carbohydrate and nitrogen metabolisms have been reported to be disturbed by the deficiency of sulphur. Low sulphur in plants is known to decrease chlorophyll concentration [7, 8] and thus indirectly affects photosynthesis [9]. Activator of several enzymes such as urease, nitrogenase, nitrate reductase and ribonuclease are known to be retarded by deficiency of sulphur [10].

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Zinc is one of the first micronutrients recognized as essential for plants. It is a micronutrient that commonly limiting crop yields in soils. Zinc is transported to plant root surface through diffusion. It aids in the synthesis of plant growth substances and enzyme systems and is essential for promoting certain metabolic reactions. It is necessary for production of chlorophyll and carbohydrates. Iron plays an important role in the synthesis of chlorophyll and also helps in the absorption of other nutrients. As a constituent of chlorophyll, it regulates respiration, photosynthesis, reduction of nitrates and sulphates. Cotton yield stagnation in Pakistan is due to a few factors, like non availability of good quality of seeds, a higher incidence of water logging, shift of good cotton area to sugarcane and absence of proper plant protection measures [11].

Since average cotton yield of Pakistan is low compared with other countries. There exists an enormous potential to increase yield through adoption of modern production technologies. One of the technologies might be application of micronutrients. Present investigations report the results of application of micronutrients (Bonus, Dawn and Power) on *Earias vittella* (F.) infestation and yield component of cotton.

MATERIALS AND METHODS

A plot was earmarked at Latif experimental farm, Sindh Agriculture University, Tandojam during the kharif season of 2004 and 2005. The main purpose of said study was to know the effect of micronutrients on cotton plant growth and insect infestation. The experiment was laid out in randomized complete block design (RCBD) with seven treatments including control (check) and was replicated three times. Cotton variety CRIS-134 was sown on May, 2004 and 2005 by dibbling methods on furrows. The distance between plants to plant was 22.5 cms. and row to row was 75cms, respectively. Most of the agricultural practices i-e, thinning, weeding, irrigation and fertilizer etc. were carried out from sowing till harvest as per recommendation. The application of micronutrients viz, Bonus (P1), Dawn (P2) and Power (P3) was made at recommended doses with the shoulder mounted knapsack sprayer. The applications of micronutrients were made on 22th August and 10th September, 2004 and 2005. The pre- treatment observation was recorded one day before the application of chemicals and post-treatment observations were made at weekly intervals. Cotton plant damage was simulated by artificially removing cotton leaves and fruiting bodies.

Method of Artificial Removal of Leaves and Fruiting Bodies

Before application of agrochemicals on cotton leaves and fruiting bodies (i.e. flower buds, flowers and bolls) were removed artificially to simulate pest damage. Total leaves and fruiting bodies of 10 plants were counted at random and average number of leaves and fruiting bodies were calculated on the basis of that average, the leaves and fruiting bodies of whole treatments plot were removed. Two control treatments were maintained, one natural control in which no leaves and fruiting bodies were removed and no application of Agrochemicals was made and another control in which leaves and fruiting bodies were not removed but application of agrochemicals was carried out. The details of treatments are as under:

T1 = natural control.

T2 = 10 percent leaves + fruiting bodies removed.

T3 = 20 percent leaves + fruiting bodies removed.

T4 = 30 percent leaves + fruiting bodies removed.

T5 = 40 percent leaves + fruiting bodies removed.

T6 = 50 percent leaves + fruiting bodies removed.

T7 = treated control, in which micro-nutrients were applied.

For recording plant growth and yield components and spotted bollworm infestation of cotton, five plants were observed at random per treatment. Plant height was recorded in centimeters and volume of bolls (cms) was measured with the help of vernier caliper. The crop maturity was observed on opening of bolls as the method described by Fry [12]. The data was analyzed statistically.

RESULTS AND DISCUSSION

Plant Height

The effect of application of micronutrients on cotton plant height (Table **1**) indicates that there was significant ($F=28.26$, $DF=2,125$ $P<0.05$) effect of application of micronutrients on plant height. The minimum plant height of 84.25 ±0.31 cm was recorded in Bonus applied plants, followed by Dawn and Power micronutrients, whereas, the natural control (T_1) treatment plants attained the maximum height in present study.

Table 1: Means (± SE) Yield Parameters after Application of Micronutrients Under Field Conditions During the Years 2004 and 2005

Micronutrients	Plant height (cm)						
	T1	T2	T3	T4	T5	T6	T 7
Bonus	102.66±0.23	95.55±0.31	92.40±0.24	90.54±0.34	89.25±0.33	84.25±0.31	87.09±0.41
Dawn	107.33±0.44	98.37±0.41	95.46±0.52	92.18±0.25	91.70±0.28	85.89±0.33	88.16±0.51
Power	109.87±0.34	102.09±0.2	97.51±0.32	93.99±0.36	93.19±0.29	86.72±0.42	88.40±0.35
Micronutrients	**Volume of bolls**						
	T1	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**
Bonus	5.19±0.23	6.16±0.34	7.48±0.41	7.50±0.35	7.79±0.28	7.65±0.34	8.23±0.40
Dawn	4.85±0.36	5.15±0.45	5.60±0.34	6.28±023	7.18±0.41	7.70±0.34	7.87±0.33
Power	4.88±0.33	5.03±0.25	5.15±0.26	5.58±0.33	5.99±0.36	7.10±0.39	7.64±0.29
Micronutrients	**Yield (grams per plant)**						
	T1	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**
Bonus	61.70±0.36	65.81±0.26	69.70±0.33	73.34±0.2	79.00±0.37	88.52±0.28	91.76±0.27
Dawn	58.99±0.25	62.62±0.36	68.24±0.28	69.86±0.39	73.64±0.44	78.65±0.39	85.11±0.34
Power	58.27±0.39	60.59±0.41	65.56±0.34	66.73±0.41	70.57±0.29	71.49±0.37	79.97±0.37

	Plant height			Volume of bolls			Yield (grams per plant)		
	Micronutrients	Treatments	Dates	Micronutrients	Treatments	Dates	Micronutrients	Treatments	Dates
F– value	28.26	47.5	62.47	41.85	56.9	77.9	42.14	53.05	85.42
P– value	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001

Boll Volume

The two years (2004 and 2005) results revealed that there was a significant (F=41.85, DF=2,188 P<0.05) effect of application of micronutrients (Table **1**) on the development of boll volume in cotton. The maximum boll volume of 8.23 cm was found in cotton applied with Bonus followed by Dawn and Power with boll size of 7.87cm and 7.64 cm respectively. The cotton plants (T_1) which did not receive any treatments had the minimum boll size.

Maturity of Cotton

Application of micronutrients during the years (2004 and 2005) significantly (F=52.77, DF=2,188 P<0.05) delayed the maturity of cotton. The minimum boll opening percent (16.38%) was found in control plants after 79 days of sowing followed by micronutrients treated plots (Table **2**) whereas Bonus treatment significantly delayed the maturity of cotton plants. Which was (83.64%) after 109 days after sowing.

Yield

The results of two years (2004 and 2005) studies, effect of damage simulation and use of micronutrients on cotton yield is shown in (Table **1**). The data indicated that there was significant effect of application of micronutrients on yield of cotton (F= 42.14, DF=2,188 P, 0.05). The maximum yield was recorded with the application of Bonus followed by Dawn, Power and minimum yield was recorded in Control plot (T_1) receiving no micronutrients treatments. Micronutrients were applied to compensate for damage and enhance crop yield. There are many studies reported in literature which support findings of present study.

Sawan *et al.* [13] found P, ca and Zn uptake, open bolls /plant and boll weight increased with increasing P, Zn and Ca application. Lint percentage and fiber properties were unaffected by fertilizer application. Rehab *et al.* [14] reported that application of folifertilzer comprising 22% N, 21% P 17% K and small amounts

Table 2: Effect of Application of Micronutrients on Maturity of Cotton Under Field Conditions (% Open Bolls) During the Years 2004 and 2005

Micronutrients	79 days		95 days		109 days	
	Control	Treated	Control	Treated	Control	Treated
Bonus	18.44	25.86	77.95	80.66	79.36	83.64
Dawn	17.05	23.77	76.18	76.42	77.18	78.56
Power	16.38	21.85	72.81	76.19	73.92	77.34

	Micronutrients	Treatments	Dates
F – value :	52.77	68.53	77.5
P – value :	0.001	0.001	0.001

of Mg, Mo, Mn, B, Fe, Cu, S, Zn, and N fertilizer increased the number of open bolls per plant, percent lint and yield in comparison to control. Sawan *et al.* [15] reported that the earliness of harvest and yield components increased by foliar application of Cu or Mn 25 mg/L. Lint percentage and fiber properties were not significantly affected. Lei *et al.* [16] Conducted field experiments with trace elements fertilizers on cotton. The lint yield increased 2.8 to 31.2%. Trace elements fertilizers helped to promote reduced shedding of fruiting forms and improved boll size, and staple length of lint. Lou [17] determined effect of Mn fertilizer on cotton and found that it increased growth, number of sympodia and squares and promoted boll setting and reduced shedding of fruiting forms thus increasing yield. Jai *et al.* [18] reported that zinc application (10-15 ppm) increased yield and yield components in cotton. Abro *et al*. [19] found no significant effect on application of plant growth regulator (NAA) and micronutrients on multiplication of percent infestation of bollworms. However, application of plant growth regulator and micronutrients significantly delayed the maturity of cotton.

Pest Infestation

The bollworm infestation percentage caused by bollworm shows in Table **3**. On application of insecticides (Spinosad and Trizophos) was carried out on 4th August, second spray of same insecticides was carried out on 7th September to contain pest infestation. Results of two years (2004 and 2005) data indicated that infestation varied from 2.08% in the beginning of the cotton season to 6.75% in the end of the season. The analysis of variance showed significant effect of application of micronutrients on bollworm percent infestation ($F=25.62$, $DF=2,377$, $P<0.05$). Similarly treatments ($F=58.36$, $DF=2,377$, $P<0.05$) and dates ($F=77.55$, $DF=5, 377$ $P<0.05$) significantly affect the bollworm infestation.

Moreover, interaction between micronutrients and dates ($F=8.40$, $DF=10,377$, $P<0.05$), treatments and dates ($F=2.79$, $DF=30,377$, $P<0.05$) and micronutrients, treatments and dates ($F=1.41$, $DF=60,377$, $P<0.05$) are highly significant.

Furthermore, on overall basis, analysis of data on weekly observations indicated that bollworm infestation was significantly lower in Bonus treated treatments followed by Dawn and Power. Application of Spinosad and Trizophos insecticides had played significant role in reduction of bollworm infestation in both (2004 and 2005) two years.

Cotton crop suffer heavy losses due to the infestation of sucking and bollworms insect pests from sowing to harvesting stages. Growth regulators and micronutrient application provide resistant against these pests, as well as these products also compensate the removal of leaves and fruiting bodies to simulate insect damage (Herbert *et al.* [20]. Abro *et al*. [19] found no significant effect on application of plant growth regulator (NAA) and micronutrients on multiplication of percent infestation of bollworms. However, application of plant growth regulator and micronutrients significantly delayed the maturity of cotton. Graham *et al.* [21] evaluated imidacloprid as a seed treatment insecticides against insect pest in cotton and plant height, percent square retention, total squares, bloom counts and yield increased compared with control. Ruscoe *et al.* [22] studied effects of

Table 3: Means (±SE) Percent Infestation of Cotton Fruiting Bodies Per Plant after Application of Micronutrients Under Field Conditions During the Years 2004 and 2005

Micronutrients Week/ month	Treatments						
(Bonus)	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**
July 4	5.46	3.06	3.08	2.92	2.64	2.26	2.08
August 1	5.59	3.15	3.17	2.99	2.71	2.31	2.12
August 2	5.67	3.20	3.23	3.05	2.75	2.35	2.17
August 3	5.85	3.29	3.30	3.13	2.83	2.42	2.22
August 4	6.08	3.42	3.42	3.23	2.93	2.50	2.30
September 1	6.30	3.55	3.56	3.36	3.04	2.59	2.38
Mean(±S.E)	5.83±0.12a	3.28±0.07b	3.29±0.07b	3.11±0.06bc	2.82±0.06c	2.41±0.05cd	2.21±0.06d
(Dawn)	T1	T2	T3	T4	T5	T6	T7
July 4	5.71	3.48	3.50	3.32	2.99	2.57	2.36
August 1	5.84	3.56	3.60	3.42	3.08	2.64	2.42
August 2	5.93	3.63	3.66	3.47	3.14	2.68	2.46
August 3	6.12	3.73	3.76	3.55	3.21	2.75	2.52
August 4	6.36	3.87	3.88	3.67	3.32	2.84	2.60
September 1	6.62	4.02	4.04	3.82	3.45	2.96	2.71
Mean(±S.E)	6.10±0.13a	3.72±0.08b	3.74±0.08b	3.54±0.07bc	3.20±0.06c	2.74±0.05d	2.51±0.05e
(Power)	T1	T2	T3	T4	T5	T6	T7
July 4	5.80	3.54	3.56	3.38	3.04	2.90	2.80
August 1	5.95	3.63	3.66	3.47	3.14	2.98	2.87
August 2	6.05	3.70	3.72	3.53	3.20	3.04	2.92
August 3	6.25	3.80	3.83	3.61	3.27	3.11	2.99
August 4	6.48	3.94	3.95	3.73	3.38	3.22	3.09
September 1	6.75	4.10	4.11	3.88	3.50	3.35	3.21
Mean(±S.E)	6.21±0.14a	3.79±0.08b	3.81±0.08b	3.60±0.07b	3.25±0.05c	3.10±0.06cd	2.98±0.06d

In a column means followed by same letter are not significantly different at P<0.05.

	Micronutrients	Treatments	Dates
F – value:	25.62	58.36	77.55
P – value:	0.0052	0.0001	0.0001

various insecticides on cumulative insect feeding and fruit initiation in cotton and recorded that application of insecticides decreased the duration of feeding and resulted the fruit set. Dale and Hein Richs [23] stated that insecticides effect plant growth, vigor and yield components. Insecticides might influence plant nutrition and cytological and physiological characteristics. Improved plant growth through insecticide stimulation could influence the ability of the host plants to with stand phytophagous insects. Thoxton *et al.* [24] reported that insecticide treated plots had significantly more bolls set (29%). Boll retention ranged from 22 to 35% in insecticide treated plots compare with 13-22% in non-treated plots. Lint yield averaged 556 lbs/acre for insecticide treated and 284 Lbs for non-treated plots. Herbert [25] examined the control of insect pests in cotton crop with selected organophosphates, carbamates, imidacloprid and spinosad and found that all treatment reduced insect pest's damage and in most cases, the reduction was significant. Almost similar observations were recorded in the present study.

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