Research Article

Growth Yield and Yield Components of Cotton as Influenced By NPK Ratios in Combination of Foliar Application of Zinc Levels under Tandojam Conditions

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Citation
Aneel Ahmed Korejo, Pir Ahmed Naqi Shah, Tanveer Ali Sial, Shahzad Ali, Altaf Hussain Lahori, Abdul Majid Narej and Zahoor Ahmed Channo. Growth Yield and Yield Components of Cotton as Influenced By NPK Ratios in Combination of Foliar Application of Zinc Levels under Tandojam Conditions. Pure and Applied Biology. Vol. 4, Issue 2, 2015, pp 268-274

Received: 04/02/2015 Revised: 17/03/2015 Accepted: 20/04/2015

Abstrac

The performance of Cotton (*Gossypium hirsutum* L.) was evaluated using various NPK ratios + foliar application of zinc levels at Agriculture chemistry Section (Soils), Agriculture Research Institute, Tandojam, Pakistan during kharif 2013. The experiment was laid out in randomized complete block design (RCBD) with four replications. Five NPK ratios with combination of five foliar applications of zinc levels T_1 = 140-80-60 + 0% Zn (foliar applied zinc zero time), T_2 = 140-80-60 + 2% Zn (foliar applied zinc one time), T_3 = 140-80-60 + 2% Zn (foliar applied zinc two time), T_4 = 100-60-40 + 2% Zn (foliar applied zinc three time), T_5 = 100-60-40 + 2% Zn (foliar applied zinc four time) were used. Five NPK ratios with combination of five foliar applications of zinc levels were found significant for all mentioned parameters. Plots treated with NPK ratio 100-60-40 kg ha^{-1} + 2% four times foliar application of zinc produced maximum plant height (142 cm), sympodial branches $plant^{-1}$ (27), productive bolls $plant^{-1}$(34), staple length (31.75 mm), seed weight $plant^{-1}$ (109 g), ginning out turn (G.O.T) (37.26%) and seed yield (3189 kg ha^{-1}) as compared with NPK ratio @ 140-80-60 kg ha^{-1} + 0% foliar application of zinc. It was concluded from this study that sowing of cotton with NPK ratio @ 100-60-40 kg ha^{-1} + 2% four times foliar application of zinc seems to the best choice for cotton producer in the agro-climatic condition of Tandojam.

Key words: Cotton (*Gossypium hirsutum* L.); NPK ratios; foliar application; yield

Introduction

Cotton (*Gossypium hirsutum* L.) is an industrial crop which has an important place in the world agriculture and trade. Cotton is a significant crop all over the world and an essential one for Pakistan as it can easily be cashed, therefore, brings a good wealth for the country. It is grown in plain areas of Sindh and Punjab contributing 8.2% of the total income earned in agricultural sector and 3.2% in the country income increasing the overall national income by 3.2 billion dollars [1]. The 1.3 million farmers (out of a total of 5 million) cultivate cotton over 3 million hectares, covering 15% of the cultivable area in the country. Cotton and cotton products contribute 10% to GDP and 55% to the foreign exchange earnings of the country [2]. It is grown in plain areas of Sindh and Punjab contributing 8.2% of the total income earned in agricultural sector and 3.2% in the country income increasing the overall national income by 3.2 billion dollars [3]. Nutrients play the major role in the production of cotton crop. The essential nutrients, which are taken in small quantities, support the uptake of NPK in the plants. Among the micro-nutrients, boron is considered very important for seed cotton yield as well as its yield components like boll weight, boll number and lint yield [4], crop grow vigorously [5]. Nitrogen is thought to be the main fertilizer for crop production, unfortunately major portion of it is lost [6]. Phosphorus mostly applied in the form of SSP plays a vital role in cotton production; and its response to cotton has been positive and economical [7]. Conversely, low soil P levels, uptake and yet the rising prices of P fertilizers have increased the input farming cost. Potassium supply on the other hand is very essential during the entire cotton growth [8]. Its deficiency ends up in poor yield and fiber quality [9] and there is less tolerance to pest and disease [10].

Essential trace elements are often called "micronutrients" because they are required in small, but in critical concentrations by living organisms. Out of 80 million hectare (Mha) geographical area of Pakistan, 22 Mha are cultivated. The cultivated soils of the country have derived from alluvium and loess, and are low in organic matter and many essential nutrients. The deficiency of Zn is the common feature of these soils. Being arid to semi arid area, about 75% of cultivated area is irrigated while the rest is rain-fed. The major cropping systems in the country are cotton-wheat, rice-wheat and mixed cropping like maize based and sugarcane based systems [11]. Zinc (Zn) is a micronutrient essential for normal healthy growth and reproduction of plants, animals and humans. In plants, Zn plays a key role as a structural constituent or regulatory co-factor of a wide range of different enzymes [12]. According to a survey about 70% of the soils used for growing crops in Pakistan have low levels of available Zn [11]. Zinc deficiency in plants does not only reduce the yield but also the nutritional quality of crops. Hence soil conditions and agronomic practices are conducive to the incidence of micronutrient deficiencies in plants [13].

Thus micronutrients application to cultivation zone may not fulfill crop requirement. Foliar spray of these micronutrients has been reported to be equally or even more effective as soil application [14] to overcome micronutrients deficiency in subsoil [15]. Have reported increase in crop production due to micronutrients application and had advocated foliar application to be 6-20 time more efficient than soil application, depending on soil type. Recently, [16] also reported better crop production for foliar application. Therefore, the present research was conducted to find out to evaluate the effect of NPK and foliar application of zinc levels on cotton.

Materials and Methods

The experiment was conducted at Agriculture chemistry Section (Soils), Agriculture Research Institute, Tandojam, Pakistan during kharif 2013. The experiment was laid out in randomized complete block design (RCBD) with four replications. .

Treatments = (NPK kg ha^{-1} + (%) Zn ha^{-1})

T_1 = 140-80-60 + 0% Zn (foliar applied zinc zero time)

T_2= 140-80-60 + 2% Zn (foliar applied zinc one time)

T3= 140-80-60 + 2% Zn (foliar applied zinc two time)

T_4= 100-60-40 + 2% Zn (foliar applied zinc three time) and

T_5= 100-60-40 + 2% Zn (foliar applied zinc fourth time)

Zinc was applied in the form of $ZnSO_4$ (33% Zn) each foliar application of zinc was applied after 20 days interval managed by weighing on electronic balance. Recommended dose of nitrogen and phosphorus was applied as usual. Nitrogen was applied in the form of Urea in three splits. The first split application of nitrogen (1/3 N) was done at the time of sowing, the second (1/3 N) at first irrigation and the final split application (1/3 N) was done at 3rd irrigation. Full dose of phosphorus in the form of DAP and potash in the form of SOP was applied at the time of sowing. Irrigation was applied as per the schedule. The weeds were controlled by interculturing at 1st and 2nd irrigations. Plot size of 5 x 4.5 m with 6 rows and 75 cm spacing. Crop was sown in the 2th week of May @ 20 kg seed ha^{-1} using cotton cultivar Sindh-1 with the help of single coulter hand drill. Agronomic practices were carried out uniformly for all the experimental units throughout the growing season. Data were taken on plant height (cm), sympodial branches $plant^{-1}$, productive bolls $plant^{-1}$, staple length (mm), seed weight $plant^{-1}$ (g), ginning out turn (G.O.T) (%) and seed yield (kg ha^{-1}).

Plant height for all the treatments in each replication was measured with the help of a measuring tape from the base to tip of the ten randomly selected plants in two central rows and then average plant height was calculated. Number of seeds $plant^{-1}$ was recorded by selecting five plants randomly from each plot counted no of seeds $plant^{-1}$ and averaged. Four central rows in each sub plots were harvested, sun dried and threshed. Seed weight was taken with the help of electronic balance and then converted into kg ha^{-1} by the following formula.

Grain yield (kg ha^{-1}) =

$$\frac{\text{Grains weight in four rows (kg)}}{\text{No of rows x Row length x R-R}} \times 10{,}000\ m^2$$

All data collected were subjected to analysis of variance (ANOVA) with the help of statistical software **[17]**. Upon significant F-Test, least significance difference (LSD) test was used for mean comparison to identify the significant components of the treatment means.

Results and Discussion

Plant height (cm)

Data presented in Table 1 indicated that the crop receiving zinc foliar at NPK ratio 100-60-40 + 2% Zn the four times produced the plants of maximum height (142 cm), closely followed by T_4 = three time application with plant height of 137 cm. While the lowest plant height of 119 cm was recorded under the control treatment, where zero time foliar application. The plant height of cotton variety SINDH-1 was consecutively improved with each increased with the increase the foliar zinc. However, this increase in plant height was not significant (P>0.05) when more decrease the NPK doses, this indicates that zinc also important for economic impact on plant height of cotton variety SINDH-1. The possible

reason could be that zinc enhances root growth, cell division and nucleus formation which produces taller plants the results are at par with [12] whose reported that plant height increase significantly when 3 time foliar application of zinc levels increased while plant have no foliar application of zinc have shorter stature.

Sympodial branches plant^{-1}

Mean values of cotton cultivar SINDH-1 indicated that NPK ratio 100-60-40 + 2% Zn four time foliar application of zinc resulted in maximum sympodial branches (27) plant^{-1}, closely followed by T_4 = 100-60-40 + 2% Zn (25) sympodial branches plant^{-1} recorded in plots receiving the four time foliar application of zinc. The decreased the foliar application zinc resulted in considerable decrease in the sympodial branches i.e. 24 and 22 plant^{-1}, respectively. In the same way, the minimum 20 sympodial branches plant^{-1} were recorded in (control) plots. The sympodial branches plant^{-1} in cotton was positively influenced by increasing the foliar application. The results are in conformity with those of [18] who stated that phosphorus is responsible for good root growth which directly affected sympodial branches plant^{-1} because the least sympodial branches plant^{-1} were recorded from the plot which receive no foliar application of zinc.

Productive bolls plant^{-1}

Mean value of data in Table 1 indicated that plots treated with NPK ratio 100-60-40 + 2% Zn four times of foliar application produced maximum productive bolls (34) plant^{-1}, followed by T_4 = 100-60-40 + 2% Zn three times of foliar application Zn, two times of foliar application and one time of foliar application with 33, 31 and 29 productive bolls plant^{-1}, respectively. However, the lowest 28 productive bolls plant^{-1} were recorded under control, where zinc application was not applied. This greater productive bolls plant^{-1}under four times of foliar was mainly the result of improved plant height and subsequent increase in the sympodial branches plant^{-1}. There was a successive increase in the productive bolls plant^{-1} with each increased foliar application of zinc. These results agree with Li et al. [19] who stated that the productive bolls plant^{-1} increased with increasing of foliar application of zinc up to 10 kg ha^{-1}.

Staple length (mm)

Statistical analysis of staple length data showed in Table 1 that NPK+ foliar application of zinc levels had significant effect on staple length. Plots supplied with zinc had significantly higher staple length as compared to control plots. The data indicated that the NPK ratio 100-60-40 + 2% Zn four time foliar application of zinc resulted in maximum staple length 31.75 mm, closely followed by 29 mm staple length recorded in plots receiving the T_4 = 100-60-40 + 2% Zn three time foliar application of zinc. The decreased the foliar application zinc resulted in considerable decrease in the staple length i.e. 26.25 and 24.5 mm, respectively. In the same way, the minimum 21.75 mm staple length was recorded in (control) plots. The staple length of cotton was positively influenced by increasing the foliar application of zinc. These results agree with the findings of [20] who reported that the foliar application of zinc fertilizer significantly increased the staple length of cotton over control plots.

Seeds weight plant^{-1} (g)

Statistical analysis of the data indicated that NPK+ foliar application of zinc levels had significant effect on seeds weight plant^{-1}. Seeds weight plant^{-1} was increased with increase in foliar application of zinc levels. The results indicated that the seeds weight plant^{-1} was significantly maximum (109 g) under receiving the NPK ratio 100-60-40 + 2% Zn four times foliar application, closely followed by T_4 = 100-60-40 + 2% Zn three times foliar application with (100 g)

Table-1. Plant height (cm), Sympodial branches plant^{-1}, productive bolls plant^{-1}, staple length (mm), seed weight plant^{-1} (g), ginning out turn (G.O.T) (%) and seed yield (kg ha^{-1}) of cotton as affected by NPK and foliar application of zinc levels.

Treatments	Plant height (cm)	Sympodial branches plant^{-1}	Productive bolls plant^{-1}	Staple length (mm)	Seed weight plant^{-1} (g)	G.O.T (%)	Seed yield (kg ha^{-1})
N-P-K 140-80-60 + 0% Zn (foliar applied zinc zero time)	119 d	20 e	28 e	21.75 d	92 e	33.07 c	2254 d
N-P-K 140-80-60 + 2% Zn (foliar applied zinc one time)	130 c	22 d	29 d	24.50 bc	98 d	34.40 d	2617 c
N-P-K 140-80-60 + 2% Zn (foliar applied zinc two times)	134 c	24 c	31 c	26.25 b	101 c	34.94 b	2729 bc
N-P-K 100-60-40 + 2% Zn (foliar applied zinc three times)	137 ab	25 b	33 b	29 ab	104 b	36.10 ab	2902 ab
N-P-K 100-60-40 + 2% Zn (foliar applied zinc four times)	142 a	27 a	34 a	31.75 a	109a	37.26 a	3189 a
LSD (0.05)	4.89	0.92	0.78	1.84	1.85	0.53	439

Means in the same category followed by different letters are significantly different at P ≤0.05 levels. ns = non-significant

seeds weight plant^{-1}. However, the lowest seeds weight (92 g) plant^{-1} was recorded under control, where no foliar application of zinc. This greater seeds weight plant^{-1} under maximum times receiving foliar zinc was mainly the result of improved plant height and subsequent increase in the sympodial branches plant^{-1}. There was a successive increase in the seeds weight plant^{-1} with each increased foliar application of zinc fertilizer. These results agree with those of [5] who reported that the foliar application of zinc produced maximum seeds weight plant^{-1}.

Statistical analysis of G.O.T (%)

Statistical analysis of G.O.T (%) data showed in table 1 NPK+ foliar application of zinc levels had significant effect on G.O.T (%). G.O.T (%) was increased with increase in foliar application of zinc levels. Plots supplied with zinc had significantly higher G.O.T (%) as compared to control plots. The G.O.T was highest (37.26 %) in plots received NPK ratio 100-60-40 + 2% Zn four times foliar application of zinc, closely followed by the cotton crop receiving T4= 100-60-40 + 2% Zn zinc foliar three times with G.O.T of 36.10 and 34.94 %, respectively. However, the lowest G.O.T of 33.07 % was recorded in plots T_1 = 140-80-60 + 2% without foliar zinc (control). The G.O.T was gradually improved with increasing foliar zinc application. Thus, for obtaining economical G.O.T (%) in cotton variety SINDH-1, three times foliar application zinc would be enough. Similarly results were reported by [11] that with the foliar application of zinc the nutrients accumulation increased and the G.O.T (%) ultimately increased.

Seed yield (kg ha^{-1})

Mean value of data in Table 1 indicated that plots treated with NPK ratio 100-60-40 + 2% Zn four times of foliar application produced highest seed yield of (3189 kg ha^{-1}) was obtained, closely followed by seed yield of (2902 kg ha^{-1}) achieved from the plots receiving NPK ratio 100-60-40 + 2% Zn tree time foliar zinc. However, the minimum seed yield of (2254 kg ha^{-1}) was recorded in plots receiving NPK ratio 140-80-60 + 2% no foliar zinc (control). This higher seed yield kg ha^{-1} under four times foliar zinc was mainly associated with improved sympodial branches, greater opened bolls, reduced unopened bolls and increased seed yield plant^{-1}. These parameters were markedly affected by foliar zinc application. Moreover **[19]** found that zinc ($ZnSO_4$) application promoted nutrient (N, P, and K) uptake, utilization, and metabolism, slightly increased root and shoot growth, bloom, dry matter production, and improved cotton quality as a result yield increased with the increase in foliar application of zinc level up to 15 kg ha^{-1} as compared with control plots.

Conclusion and Recommendations

From present research it can be concluded that plots treated with NPK 100-60-40 kg ha^{-1} + 2% four times foliar application of zinc produced maximum plant height (cm), Sympodial branches plant^{-1}, Productive bolls plant^{-1}, Staple length (mm), Seed weight plant^{-1} (g), Ginning out turn (G.O.T) (%) and Seed yield (kg ha^{-1}) significantly and therefore, it is recommended that cotton should be sown in Tandojam with NPK 100-60-40 kg ha^{-1} + 2% four times foliar application of zinc for improve growth yield and yield components of cotton.

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