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Influence of phasing and different levels of zinc application on yield of cotton and soybean in Vertisol

Sapana Ingle, Katkar R. N.
Department of Soil Science and Agricultural Chemistry, Dr. PDKV Akola

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ABSTRACT :
The field experiment was conducted to study effect of phasing and levels of Zinc application on yield of cotton and Soybean and soil fertility status during kharif season 2017-18 and 2018-19 at Research Farm, All India Co-ordinated Research Project on Micro and Secondary Nutrients and Pollutant Elements in Soils and Plants, Department of Soil Science and Agricultural Chemistry, Dr.Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The experiment was laid in a Factorial randomized block design with two factors viz, Factor A as phasing of zinc application and factor B as levels of Zinc application. The significantly highest seed cotton yield (11.03 q ha^{-1}) and stalk yield (20.22 q ha^{-1}) were recorded with application of zinc @7.5 kg ha^{-1}in alternate year while,the significantly highest seed yield (27.70q ha^{-1}) and straw yield (39.43 q ha^{-1}) were recorded with application of zinc @ 7.5 kg ha^{-1} in alternate year. Alternate year application of zinc recorded highest grain and straw yield followed by zinc application in every year and first year.
Key words: Zinc Phasing, levels, seed yield, straw yield, Vertisols, alternate year.

I. INTRODUCTION

Cotton is one of the important cash as well as fibre crop and play vital role in the history and civilization of mankind, with enormous potential in textile industries and is a means of livelihood for millions of farmers and those concerned with its trade, processing, manufacturing and other allied industries. No agricultural commodity in the world exercised a profound influence on economy as cotton had done from the time immemorial. Therefore, it is popularly known as white gold. Cotton seed contains about 15-20 per cent oil and is used as vegetable oil and in soap industries. After extraction of oil, the left-over cake is proteinous which is used as cattle feed. It is the king among the fibre crops, taking into consideration the economic impact it generates. Besides, its enormous role in national economy, its contribution in the foreign exchange is tremendous. Nearly one third of India's export earnings are from textile sectors of which cotton alone contributes nearly 70 per cent of raw material. Cotton contributes 29.8 per cent of the Indian agricultural gross domestic product (Barwaleet al., 2004). Still there exits large potential for export of raw cotton and value-added products.

Soybean is one of the important oilseed as well as leguminous crop. It is the cheapest and richest source of high quality protein (40%). It supply most of the nutritional constituents essential for human health. Soybean occupies an intermediate position between legumes and oilseed. Soybean helps to builds up the soil fertility by fixing atmospheric nitrogen through nodules. Symbiotically soybean fixes nitrogen and leaves about 25 per cent for succeeding crop. All these qualities have made it an ideal crop in rotation. In India, the area under this crop increased due to its high yielding potential and multifarious industrial uses. Soybean is called as boon of malnourished world because of its high nutritive value mainly due to its high protein (40%), oil (20%) and carbohydrate (35%).In India it is mainly grown as 'oilseed crop'. Hence, soybean is called as "Wonder bean" or "Miracle bean". Soybean occupies an intermediate position between legumes and oilseed.

The plant requires essential nutrients viz., primary, secondary and micro nutrients which have assumed a greater importance in a modern agriculture. Among the micro nutrients, zinc deserves special attention. Recently, zinc has gained key position in intensive cropping system with the use of organic manures resulting in the depletion of zinc from soils of majority of agriculturally productive areas of Maharashtra. However, soil has not received due attention because of the presumption that these soils have adequate reserves of micronutrients. Though, large group of soil contain sufficient amount of total zinc (10-300 mg kg-1) but, its availability in soil is very less (Swine, 1995).

Food and Agriculture Organization (FAO) has determined that zinc is the most commonly deficient micronutrient in agricultural soils; almost 50 per cent of agricultural soils are Zn deficient. Plants growing on potentially zinc-deficient soils have reduced productivity and contain very low concentrations of zinc in the edible parts (such as in cereal grains). Therefore, zinc deficiency represents a serious nutritional and health problem in human and cattle populations, especially in the developing world where cereal-based foods are the dominating source of diet. Therefore, the present investigation was carried out to assess the impact of phasing and different levels of Zn application on productivity of cotton and soybeanin Vertisols.

II. MATERIALS AND METHODS:

Climate:

Akola is situated at 307.41 meters above mean sea level at 220 42' North latitude and 770 02' East longitude and lies in subtropical continental climate. The climate of Akola is characterized by a hot summer and general dryness throughout the year except during South-West monsoon (June to 15th Sept.). Major rainfall (80 per cent) received in the month of June to September i.e. in monsoon season; however, 20 per cent rainfall received during post monsoon season. Akola receives an annual mean precipitation of 805.6 mm in about 46 days and grouped under assured rainfall zone. During monsoon July is the wet month with 253.1 mm average monthly rainfall. The mean maximum temperature varies from 29.0 oC to about 42.7 oC in May, whereas, the mean minimum temperature varies from 10.3 oC during winter to 27.6 oC in summer. The data collected on rainfall, number of rainy days, temperature, relative humidity, sunshine hours and evaporation at meteorological observatory, Dr.Panjabrao Deshmukh Krishi Vidyapeeth, Akola during the period of experimentation (2017-18 and 2018-19)

Experimental Site :

The experiment 'Influence of phasing and different levels of zinc application on yield of cotton and soybean in Vertisol' Conducted during 2017-18 and 2018-19 at Research Farm, All India Co-ordinate Research Project on Micro and Secondary Nutrients and Pollutant Elements in Soils and Plants, Department of Soil Science and Agricultural Chemistry, Dr.Panjabrao Deshmukh Krishi Vidyapeeth, Akola. This experiment was superimposed on the ongoing experiment which was started during the year 2013-14 under AICRP on Micro and Secondary nutrients. The present experiment was conducted on same site and same randomization.

Soil of experimental site:

The soil of experimental site was deep black swell shrink, montmorillonitic mineralogy with clay texture and classified under Vertisols. The initial soil properties at the start of experiment (kharif, 2013-14) was slightly alkaline (8.26), non-saline (0.29 d S m-1), moderately calcareous (8.13 %) and medium in organic carbon (5.30 g kg-1). The available nitrogen was low (216.2 kg ha-1), medium in available phosphorus (14.17 kg ha-1) and high in available potassium (346.2 kg ha-1) while marginal in available sulphur (12.42mg ka-1). The experimental soil was deficient in DTPA – zinc (0.48 mg kg-1) and sufficient in DTPA- Fe, Mn and Cu.

Experimental layout:

The experiment was laid in a Factorial randomized block design with two factors viz, Factor A as phasing of zinc application and factor B as levels of Zinc application with 12 treatments (1 control) and three replications. Factor a (3 phasing of Zn) and factor b (4 levels of Zn).

Treatment details:

Factor (a) :Phasing of Zinc application (P)

P1 - once in six years
P2 - Alternate year
P3 - Every year

Factor (b) : Levels of soil application of zinc (Zn)

Zn1 - 2.5 kg Zn ha^{-1}
Zn2 - 5 kg Zn ha^{-1}
Zn3 - 7.5 kg Zn ha^{-1}
Zn4 - 10 kg Zn ha^{-1}

Methods adopted:

The seed of cotton and soybean was purchased from market and sown in kharif season by dibbling and drilling respectively at the rate 12-15 kg^{-1} for cotton (Ajit-199 BGII) for soybean @ 75 kg ha^{-1} (JS-335). For the first year of cotton crop the Recommended Dose Fertilizers N, P_2O_5, K_2O was applied @ 60:30:30 basal doses out of this 50% of nitrogen, phosphorus and potassium were applied through urea, di-ammonium phosphate, muriate of potash and 50% of N was applied at 30 DAS through urea. Soil application of zinc was carried as per treatments (Zn1, Zn2, Zn3, Zn4) at the time of sowing @ (2.5, 5, 7.5, 10 kg Zn ha^{-1}) through zinc sulphate ($ZnSO_47H_2O$). $ZnSO_4$ was mixed with FYM and applied in soil to treatment plots. During second year for soybean crop the RDF of N, P2O5, K2O was 30:75:30. Soil application through urea, di-ammonium phosphate and murate of potash carried as basal dose at the time of sowing and zinc was applied as per treatments.

Seed cotton and stalk yield:
After harvesting, seed cotton and stalk yield of cotton of each plot was recorded per hectare yield was calculated.

Seed and straw yield of soybean:
After harvesting, soybean grain and straw yield of each plot was recorded per hectare yield was calculated.

III. STATISTICAL ANALYSIS

The treatment Zn0 as the no application of zinc and P0 as no phasing was considered as control in the present investigation. The data recorded for each observation in this investigation was analysed statistically with desired statistical design i.e. Factorial Experiment with one additional treatment (or control) which was describe by P0Zn0 and standard error and critical difference for each observation was determined. The statistical analysis of the data was carried out by statistical methods suggested by Gomez and Gomez (1984).

IV. RESULT AND DISCUSSION

4.1 Effect of Phasing and Levels of Zinc on Seed cotton and stalk yield of cotton

4.1.1 Seed cotton and stalk yield

The data pertaining to seed cotton and stalk of cotton as influenced by various treatments are presented in Table 1 and seed cotton yield graphically depicted in Fig 1.

From the data, it is observed that seed cotton yield registered in the range of 9.89 to 10.20 q ha^{-1} due to phasing of zinc application and found non-significant. The highest value of seed cotton yield (10.20 q ha^{-1}) in phasing was observed in alternate year of zinc application. It could be noticed that, the reduction in the seed cotton yield in the treatment every year application (P3) of zinc as compared to alternate year of zinc application (P2) by 2.25 per cent. The reduction in the seed cotton yield could be attributed to every year application of zinc to soil reduce yield as compared to alternate year application of zinc in Cotton-Soybean rotation.

From the data, it is observed that stalk cotton yield recorded in the range of 17.39 to 18.50 q ha^{-1} due to phasing of zinc application and found significant. The highest value of stalk cotton yield (18.50 q ha^{-1}) in phasing was observed in alternate year of zinc application. It could be noticed that, the reduction in the stalk cotton yield in the treatment every year application (P3) of zinc as compared to alternate year of zinc application (P2) by 2.10 per cent. The reduction in the stalk cotton yield could be attributed to every year application of zinc to soil reduce yield as compared to alternate year application of zinc in Cotton- Soybean rotation.

Maninder Kaur et al., (2007) reported that the soil application of zinc sulphate with foliar application of ferrous sulphate increase the seed cotton yield per plant as compare to control and other treatments.

The finding corroborates with results reported by Polara et al., (2010), Jadhaoet. al., (2009) reported that zinc application increased yield over control. Similar result has been also reported by Radhika etal.,(2013) and Yasneenetal., (2013) reported that seed and stalk yield of cotton increased significantly with soil application of Zn 5.0 kg ha^{-1} as compared to control.

In case of zinc levels (Factor B), seed cotton yield recorded in the range of 9.67 to 10.52 q ha^{-1} and significantly highest seed cotton yield (10.52 q ha^{-1}) registered in the treatment of zinc @ 7.5 kg ha^{-1} (Zn3) as compared to the other treatments and followed by Zn @ 10 kg ha^{-1} (Zn4) (9.99 q ha^{-1}) and Zn @ 5 kg ha^{-1} (9.90 q ha^{-1}). It could be noticed that soil application of Zn @ 10 kg ha^{-1} decreased seed cotton yield to the extent of 5.04 per cent as compared to soil application of Zn @ 7.5 kg ha^{-1}. This indicated that the higher doses of Zn might lead to decrease in seed cotton yield due to antagonistic effect of higher doses on other treatments in the soil.

In case of zinc levels (Factor B), stalk cotton yield found in the range of 17.16 to 19.24 q ha^{-1} and significantly highest stalk cotton yield (19.24 q ha^{-1}) recorded in the treatment of zinc @ 7.5 kg ha^{-1} (Zn3) as compared to the other treatments and followed by Zn @ 10 kg ha^{-1} (Zn4) (17.81 q ha^{-1}) and Zn @ 5 kg ha^{-1} (17.80 q ha^{-1}). It could be noticed that soil application of Zn @ 10 kg ha^{-1} decreased stalk cotton yield to the extent of 5.04 per cent as compared to soil application of Zn @ 7.5 kg ha^{-1}.

Similar results were registered by Radhika et al., (2013) and Yasneenet al., (2013) confirmed that seed and stalk yield of cotton increased significantly with soil application of Zn @ 5.0 kg ha^{-1} as compared to control.

4.1.2 Interaction effect of phasing and levels of zinc on seed cotton and stalk yield ofcotton.

Interaction effect of phasing and levels of zinc was recorded significantly in (Table 1a) and treatment combination of alternate year soil application of zinc @ 7.50 kg ha^{-1}(P2 Zn3) recorded significantly higher seed cotton yield (11.03 q ha^{-1}) over all the treatment combinations and followed by (P3Zn3) and (P2Zn4). P2Zn3 combination recorded 22.69 per cent higher seed cotton as compared to control (P0Zn0). The close scrutiny of data also showed that, all the treatment combinations of P X Zn registered significantly higher seed cotton yield as compared to P0Zn0.

The results corroborate with the results reported by Ahmed et.al., (2014) reported that yield of cotton increased progressively with increasing zinc rates also, Maninder Kaur et al., (2007) reported that the soil application of zinc sulphate with foliar application of ferrous sulphate increase the seed cotton yield per plant as compare to control and other treatments.

The finding corroborates with results reported by Polara et al., (2010)Jadhaoet. al., (2009) reported that zinc application increased yield over control. This could be described that excess use of zinc with every year application creates imbalance of nutrient in soil which might lead to reduced availability to plant root ultimately decrease in seed cotton yield. Similar type of findings was reported by Atta Hussain etal., (2017).

4.2 Effect of Phasing and Levels of Zinc on Soybean seed and straw yield

4.2.1 Seed and straw yield of soybean

The data in relation to seed yield and straw yield of soybean as influenced by various treatments are presented in Table 2 and soybean seed yield graphically represented in Fig 2.

Due to phasing of zinc application (Factor A), it was observed that seed yield of soybean recorded in the range of 23.32 to 25.31 q ha^{-1} and found significant. It could be noticed that reduction in seed yield with treatment of every year application (P3) of zinc as compared with alternate year application of zinc (P2) by 2.76 per cent. The reduction in the seed yield could be attributed to every year application of zinc to soil reduced yield as compared to alternate year application of zinc.

Similar findings were also confirmed by Ghasemianetal.,(2010). Also,Kanaseet al., (2008) reported that seed and straw yield of soybean increased significantly with 7.5 kg Zn ha^{-1} application with RDF as compared to control and Sonkambaleet al., (2015) reported highest seed yield of soybean with Zn application.

2.2 Interaction effect of phasing and levels of zinc on soybean seed and straw yield of soybean.

Interaction effect of phasing and levels of zinc application was found significant for seed yield of soybean highest seed yield of soybean was found in treatment receiving alternate year application of zinc @ 7.5 kg ha^{-1}(27.70 q ha^{-1}) which was followed by treatment of 10 kg Zn ha^{-1} alternate year application (27.01 q ha^{-1}) and treatment of 5 kg Zn ha^{-1} every year application (26.12 q ha^{-1}), lowest value of seed yield was (21.27 q ha^{-1})observed with treatment of P0Zn0. Straw yield of soybean as influenced by phasing of zinc showed significant result, it was ranged from 33.99 to 36.87 q ha^{-1}. Highest straw yield was observed with alternate year application of zinc (P2) 36.87 q ha^{-1}, which was followed by every year application of zinc (P3) 35.88 q ha^{-1}. It could be noticed that, the reduction in straw yield in the treatment of every year application of zinc as compared to alternate year of zinc application by 2.68 per cent. This indicated that the higher doses of zinc might lead to decrease in straw yield due to antagonistic effect of higher doses on other nutrients in the soil.

In case of levels of zinc (Factor B) influenced straw yield significantly, it was in between 35.09 to 37.54 q ha^{-1}. Highest straw yield 37.54 q ha^{-1} was found with treatment of zinc application @ 7.5 kg ha^{-1}(Zn3) which was followed by zinc @ 10 kg ha^{-1}(Zn4) 36.64 q ha^{-1}, here the same trend was found that increasing the doses of zinc lead to decreased in straw yield of soybean by 2.39 per cent.

Interaction effect of phasing and levels of zinc was recorded non-significant for straw yield (Table 2a). Straw yield was registered in the range of 32.59 to 39.43 q ha^{-1}. Highest straw yield is found with treatment of P2Zn3 (39.43), which were followed by treatment of P2Zn4 (38.52), P3Zn3 (38.51) and P2Zn2 (37.28). P2Zn3 combination recorded 17.34 per cent higher straw yield as compared with control (P0Zn0). From the data it was clearly observed that all the treatment combination of P X Zn registered significantly higher straw yield as compared to P0Zn0. The result corroborates with the result reported by Kanaseet al., (2008) they also reported that seed and straw yield of soybean increased significantly with 7.5 kg Zn ha^{-1} application with RDF as compared to control and Sonkambaleet al., (2015)

reported highest seed yield of soybean with Zn application
The findings confirmed with results reported by Ghasemianet al., (2010). Pableet al., (2010) reported that zinc application increased the seed and straw yield of soybean over control. Similar result has been also reported by Chauhan et al., (2013) and Nandanwaret al., (2007) reported that seed and straw yield of soybean increased significantly with soil application of Zn 5.0 kg ha^{-1} as compared to control.
This could be ascribed that excess use of zinc with every year applicationcreates imbalance of nutrient in soil which might lead to reduced availability to plants root ultimately decrease in seed yield. Similar type of findings was reported by Kobraee and Keyvan (2015) and Yasari and Vahedi (2012).

V. CONCLUSION

From the present investigation the significantly highest seed cotton yield (11.03 q ha^{-1}) and stalk yield (20.22 q ha^{-1}) were recorded with application of zinc @7.5 kg ha^{-1} in alternate year it similarly, The significantly highest grain yield (27.70q ha^{-1}) and straw yield (39.43 q ha^{-1}) were recorded with application of zinc @ 7.5 kg ha^{-1} in alternate year. Therefore, it can be concluded that soybean and cotton productivity along with soil fertility status can be improved with 7.5 kg Zn ha^{-1} in alternate year.

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Table 1. Seed cotton and stalk yield as influenced by phasing and levels of zinc treatments.

Treatments	**Seed cotton yield (q ha^{-1})**	**Cotton stalk yield (q ha^{-1})**
Factor- A Phasing		
P1 - First year application only	9.89	17.39
P2 - Alternate year application	10.20	18.50
P3 - Every year application	9.97	18.11
SE (m) +	0.11	0.11
CD at 5%	-	0.34
Factor B Levels of zinc (kg ha-1)		
Zn1 : 2.5	9.67	17.16
Zn2 : 5.0	9.90	17.80
Zn3 : 7.5	10.52	19.24
Zn4 : 10	9.99	17.81

SE (m) +	0.13	0.14
CD at 5%	0.37	0.40
Interaction P X Zn	Sig	Sig
CV (%)	10.86	12.31

table 1a. Interaction effect of phasing and levels of zinc on seed cotton and stalk yield of cotton.

Treatment combinations (P X Zn)	**Yield (q ha^{-1})**	
	Seed cotton	**Stalk**
P1Zn1	9.52	16.76
P1Zn2	9.98	17.27
P1Zn3	10.21	17.99
P1Zn4	9.98	17.56
P2Zn1	9.65	17.41
P2Zn2	10.00	18.23
P2Zn3	11.03	20.22
P2Zn4	10.15	18.01
P3Zn1	9.84	17.18
P3Zn2	9.73	17.91
P3Zn3	10.33	19.52
P3Zn4	9.98	17.87
SE(m)±	0.22	0.23
CD at 5%	0.67	0.69
Control Vs other treatments		
P0Zn0	8.99	15.44
SE (m) ±	0.23	0.24
CD at 5%	0.47	0.51

Table 2. Seed and straw yield of soybean as influenced by phasing and levels of zinc

Treatments	**Seed yield (q ha^{-1})**	**Straw yield (q ha^{-1})**
Factor A Phasing		
P1 - First year application only	23.32	33.99
P2 - Alternate year application	26.01	36.87
P3 - Every year application	25.31	35.88
SE (m) +	0.28	0.26
CD at 5%	0.83	0.78
Factor B Levels of zinc (kg ha-1)		
Zn1 : 2.5	24.09	35.09
Zn2 : 5.0	24.66	36.04
Zn3 : 7.5	25.76	37.54
Zn4 : 10	25.01	36.64
SE (m) +	0.32	0.31
CD at 5%	0.95	0.90
Interaction P X Zn	Sig	NS
CV (%)	11.66	-

Table 2a. Interaction effect of phasing and levels of zinc on seed and straw yield of soybean.

Treatment combinations (P X Zn)	Soybean yield (q ha-1)	
	Seed	Straw
P1Zn1	23.15	33.42
P1Zn2	23.46	34.11
P1Zn3	23.95	34.70
P1Zn4	24.20	35.16
P2Zn1	25.14	36.53
P2Zn2	27.70	37.28
P2Zn3	27.01	39.43
P2Zn4	25.35	38.52
P3Zn1	25.71	35.33
P3Zn2	26.12	36.74
P3Zn3	24.09	38.51
P3Zn4	23.15	36.26
SE(m)±	0.57	0.54
CD at 5%	1.66	-
Control Vs other treatments		
P0Zn0	21.37	32.59
SE (m) ±	0.59	0.56
CD at 5%	1.22	1.15

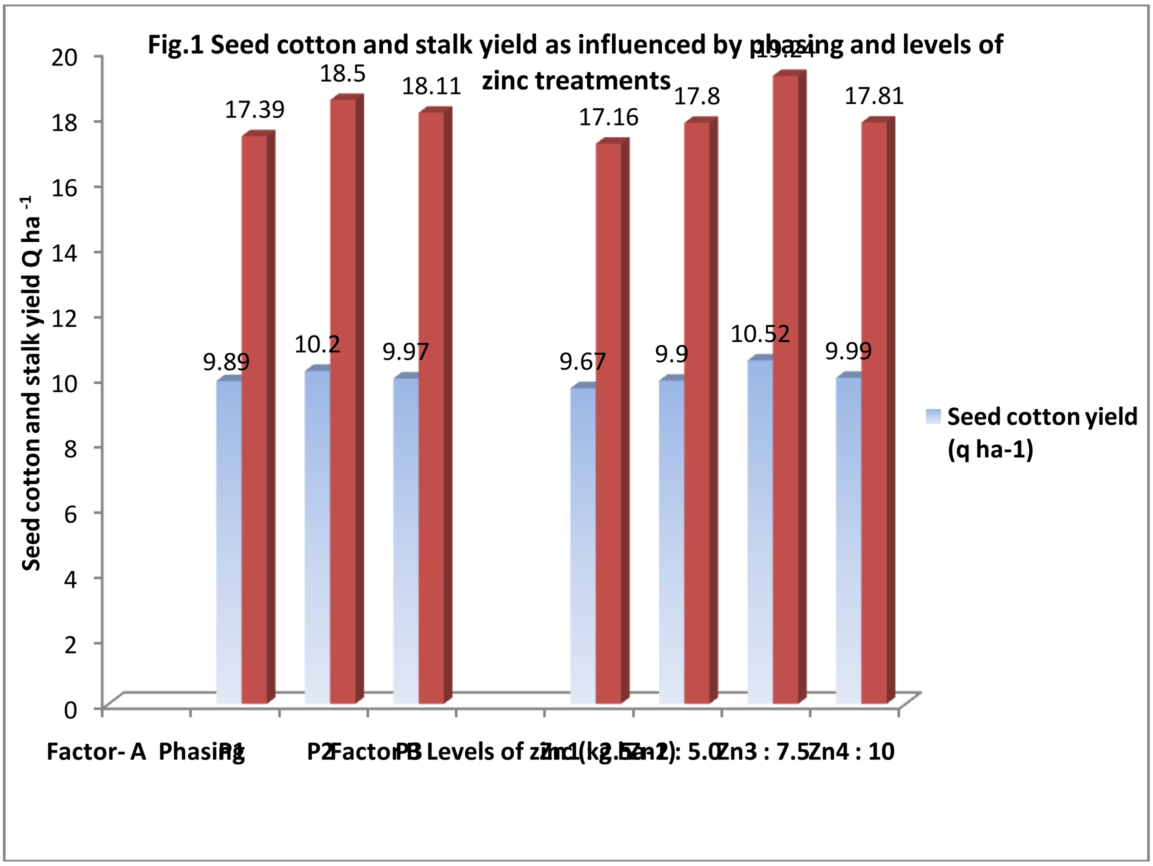

Fig.1 Seed cotton and stalk yield as influenced by phasing and levels of zinc treatments

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Fig. 2 Seed and straw yierld of Soybean as influenced by Zinc phasing and levels of Zinc application