International Journal of Advanced Multidisciplinary Research
ISSN: 2393-8870
www.ijarm.com
DOI: 10.22192/ijamr Volume 5, Issue 11 -2018

Research Article

DOI: http://dx.doi.org/10.22192/ijamr.2018.05.11.005

Improving the productivity of cotton (*Gossypium hirsutum* L.) by integrated use of macro and micronutrients under agro-climatic conditions of Bahawalnagar, Pakistan

Liaqat Ali[1], M. Akram[2], Mueenud Din[3], Ubaidur Rehman[3], M. Zafar[3], Abdul Ghafoor[4]and Zafar Yab Haider[5]

[1]Adaptive Research Station, Bahawalnagar
[2]Adaptive Research Station,Sahiwal
[3]Directorate of agriculture (F,T&A R), Vehari zone Vehari,[4]Directorate of agriculture (coordination),[5]Director General Agriculture (Extension & AR), Punjab, Lahore.
*Corresponding author: *shafqat_l@yahoo.com; drliaqatali131@gmail.com*

Keywords

Gossypium hirsutum; NPK,Zn+B+Fe+Cu; yield and yield components; Pakistan**.**

Abstract

A field experiment was conducted at farmer's field sites of Bahawalnagar District to study the effect of integrated use of macro and micronutrients on the yield and yield components of cotton varieties (cv. MNH-886 and FvH-142) during the year 2015 and 2016 . Three treatments i.e. T1 recommended NPK 340-114-92 kg ha-1,T2recommended NPK + Zn(7.5 kgha-1)+B 7.5 kgha-1+Fe(5 kgha-1) and T3recommended NPK + Zn(7.5 kgha-1)+B 7.5 kgha-1+Fe(5 kgha-1) +Cu(2.5 kg ha-1). Zinc, boron, iron and copper were applied as zinc sulphate 35%,boric acid 17%,ferrous sulphate and copper sulphate respectively were tested. The experiment was laid out in split plot design with three replications. The results of Kharif 2016 revealed that T3i.e.recommended NPK + Zn(7.5 kgha-1)+B 7.5 kgha-1+Fe(5 kgha-1) +Cu(2.5 kg ha-1) proved as the best balanced fertilizer dose for higherseed cotton yield of FH-142(2301 kg/ha) with higher number of bolls (26.2/plant) and boll weight (3.11g) followed by seed cotton yield of FH-142 (2180 kg ha^{-1}), number of bolls (24.8/plant) and boll weight (2.85g) obtained withT2i.e.recommended NPK + Zn(7.5 kgha-1)+B 7.5 kgha-1+Fe(5 kgha-1) as against the minimum seed cotton yield of 2018 kg ha^{-1}, number of bolls (19.2/plant) and boll weight (2.62g) obtained withT1i.e. recommended NPKfor FH-142. The trend of dataof Kharif 2015 and Kharif 2016 was statistically similar.

The data indicated significant relationship (R2=0.97,0.94) among boll weight and seed cotton yield for MNH-886 and FH-142, respectively during the year 2016. For sustainablecotton production, producers may need to change traditional soil fertility programs with an integrated use of macro and micronutrients. Furthermore, cotton genotype (FH-142) performed better thanMNH-886.

Introduction

Cotton (*Gossypium hirsutum* L.) is a strategic crop to sustain economy of Pakistan. The country stands 4th largest producer, 3rd largest exporter, 4th largest consumer of cotton in the world.

It contributes more than 60 percent to total foreign exchange earnings and about 8.5 percent to domestic edible oil needs (Anon. 2001). Despite this fact, the productivity of cotton is far low compared to other cotton producing countries. Optimal NPK fertilization is an important consideration for harvesting higher cotton yield, but farmers usually overuse nitrogenous fertilizer along with insufficient dose of phosphorus and potash. It is established fact that optimum nutritional requirement of cotton is of primary importance to boost its production. The mineral nutrition of cotton depends on both the cotton root's ability to explore the soil and ability to supply N, P and K nutrients on the soils (Bisson*et al*, 1994). Soil tests carried out in Pakistan showed a general lack of N, a wider spread deficiency of P and an occasional deficiency of K (Wahhab, 1985). Deficiency of N in cotton can reduce both vegetative and reproductive growth and induce premature senescence leading to potential yield loss (Gerik*et al*., 1994). Several factors, including soil type, affect cotton response to P. The critical level of P is a function of actual concentration of the labile pool that in turn determines the available P at a given time during the growth of cotton (Crozier *et al*., 2004). Potassium fertilization increased cotton yield by 9% in 2 yr. of a 3-yr. study (Pettigrew, 2003). Abd El-Mohsen *et al*.,(2015) investigated that the application of recommended dose of mineral N and K fertilizer (70 kg N fed^{-1} and 24 kg K_2O fed^{-1}) gave the highest values of plant height, number of open bolls plant-1 , boll weight, seed index, lint %, seed cotton yield $plant^{-1}$ and seed cotton yield fed^{-1}.

Deficiency of more than one nutrient is frequent in alkaline soils of Pakistan (Anon., 1998; Imtiaz et al., 2010). Fageria et al., (2002) reported that with the introduction of high yielding varieties, high cropping intensity, calcareous nature and alkaline reaction soils, imbalanced application of macronutrients and low or less use of organic manures caused widespread deficiencies of micronutrients. Among fertilizers, macronutrients including: nitrogen (N), phosphorus (P) and potassium (K) play important role in foliar growth, root development, cell division, flowering, and seed and fruit formation (Brady, 1984). Similarly, micronutrients, such as, zinc (Zn), copper (Cu), iron (Fe), manganese (Mn), Nickle (Ni.) etc. are essential for plant growth, transportation of nutrients, cell formation, uptake and retention of other minerals, transformation of compounds, metabolism and energy cycles. Deficiency in any single micronutrient may hamper plant growth and subsequently foliage yield (Cioroi and Florea, 2003; Mousavi, 2011).

Among the macronutrients, excessive and indiscriminate use of P-fertilizers can affect chemical or physiological interactions in soil-plant systems. These interactions, known as phosphorus induced micronutrients disorder (Timmer and Teng, 1990) reduce solubility of micronutrients (Zn, B, Cu, Fe and Mn), which leads toward their non-availability to plants. This phosphorus induced micronutrients deficiency has been proved in various soils and crops (Wang et al., 1990; Ajourietal., 2004). Boron deficiency or excess may affect the solubility andavailability of macro-and micro-nutrients in soil (Tariq & Mott, 2007; Ahmed et al., 2008).Rational use of macronutrients (NPK) is necessary formaintaining soil fertility, as well as, ensuring solubility and availability of micronutrients.The inorganic fertilizers produce significant effects on quantity as well as quality on the produce of most of the crop plants. The productivity of cotton crop varies greatly due to addition of macro-and micro-nutrients. Among micro-nutrients,zinc,boron, iron and copper fertilizer holds significant importance in not only sustaining but also enhancing the yield of cotton. Ahmad et al, 2011 conducted an experiment on calcareous soils under irrigated conditions by using six levels of boron fertilizer i.e., 0.0, 1.0, 1.5, 2.0, 2.5 and 3.0 kg B ha-1. They concluded that application of boron fertilizer produced significant effect on enhancing biological yield of cotton. Maximum dry matter yield was achieved by addition of 3.0 kg B ha-1. They also found that the addition of various levels of boron caused substantial increase in the uptake of nitrogen,phosphorus, potassium, copper, iron, zinc and boron nutrients, while lowering down of calcium magnesium and manganese in different parts of the cotton plant. The enhanced assimilation of macro-nutrients resulted in greater production of biological yield and better growth and development of cotton plant.Ravikiran etal. (2012) conducted experiment at Agricultural College Farm, Raichur to study the effect ofmacro and soluble micronutrients on growth and yield of Bt cotton (Gossypiumhirsutum L.) under irrigation. The resultsrevealed that application of 187.5 : 93.5 : 93.5 kg NPK ha-1 in combination with 0.5 per cent tracelmicronutrient recorded the highest seed cotton yield per ha and per plant, lint index, nitrogen and phosphorus uptake andgross returns

(19.88 q ha-1, 96.99 g plant -1, 5.20, 111.94 and 32.34 kg ha-1 and ` 79,533 ha-1, respectively). Ahmad etal 2016 conducteda field experiment to determine the response of cotton to boron and zinc applications along with NPK in the soils of southern Punjab to increase the quality, growth and yield of cotton. The results showed that the integrated use of macro and micronutrients caused a significant improvement in growth, yield, nutrient uptake and fiber quality of the cotton crop. Maximum improvement in plant height (61%), boll diameter (75%), number of bolls plant-1 (100%), and fiber strength (11%) was observed in plot where boron @ 2 kg ha-1 and zinc @ 5 kg ha-1 were applied along with recommended dose of NPK. Low yield of cotton inPakistan is due to many crop husbandry problems suchas low or more plant population, water shortage, lowseed rate, improper fertilizer management, weedinfestation, insect pest and disease problems (Ahmed et al., 2009).Ali etal.,2011 determined the positive effect of boron and zinc along with NPK fertilizers on growth and yield cotton. Abid et al., 2007 concluded that soil-applied boron positively influenced yield, fiber quality and leaf boron contents of cotton (*Gossypium hirsutum* L.).Singh et al., 2015 determined the optimum effects of foliar application of nutrients on growth and yield of Bt cotton (*Gossypium hirsutum* L.).

The objective of this research was to evaluate the integrated effect of macro and micronutrients s on seed cotton yield and its components.

Materials and Methods

The experiment was conducted at farmer's field ofAdaptive Research station Bahawalnagarin the first week of May during 2015and 2016 to assess the response of cotton (cv. MNH-886 AND FvH-142) to three treatments :- T1 recommended NPK 340-114-92 kg ha-1,T2recommended NPK + Zn(7.5 kgha-1)+B 7.5 kgha-1+Fe(5 kgha-1) and T3recommended NPK + Zn(7.5 kgha-1)+B 7.5 kgha-1+Fe(5 kgha-1) +Cu(2.5 kg ha-1). Zinc, boron,iron and copper were applied as zinc sulphate 35%,boric acid 17%,ferrous sulphate and copper sulphate respectively. The experiment was laid out in split plot design with three replications.Soil sample were collected before planting crop

from the experimental sites and analysiscarried out as per method (Ryan et al. (2001)). The soil of theexperimental sites was clay loam with alkaline pH(8.4), 0.71% organic matter, 0.044% N, 4.5ppmavailable phosphorous & 138 ppm available potash. Av. Zn(mg/kg)0.71-o.75Av. B(mg/kg)0.44-0.48Av.Cu(mg/kg)0.20-0.25Av.Fe(mg/kg)2.65-2.92. The values demonstrated that soil was medium to heavy textured, alkaline in reaction, free of excessive soluble salts, low in organic matter, nitrogen and phosphorus. The potassium level was inadequate to capture an economic yield. The micronutrients were also below their critical level.

Well adopted cotton varieties MNH-886 and FH-142 were sownduring firstfortnight of May on a well prepared seed bed at 75 cm row torow and 22.5 cm plant to plant distances. Full dose of P_2O5 as single superphosphate and K as sulphate of potash was applied at planting and 340 kgN as urea was applied in five equal splits. Zn(7.5 kgha-1)+B 7.5 kgha-1+Fe(5 kgha-1) and Cu(2.5 kg ha-1) were applied at 30 days after sowing. Pre-emergence weedicide i.e. pendimethaline and acetachlore @ 2.5 and1.25 lha^{-1} was applied to eradicate weeds. All required agronomic practices and plant protection measures were carried out accordingly. The seed cotton was harvested plotwise and finally converted into kg per hectare. Ten plants from each treatment were selected at random for counting number of bolls per plant and 25 bolls were collected from each treatment for boll weight determination. The average maximum temperature (44.25C and 45.8ºC), minimum temperature (29.64°C and 30.17ºC) and total rainfall (99 mmand 56 mm), during 2015 and 2016, respectively were recorded during the crop growth period. The data on yield and yield components were subjected to statistical analysis andtreatment differences were determined using LSD (Gomez and Gomez. 1984).

Results and Discussion

The results (Tables 1) revealed that seed cotton yield and its components varied significantly ($p<0.05$) with integrated use of macro and micronutrients during 2015.

TABLE 1: Effect of integrated use of macro and micronutrients on the seed cotton yield in the agro-climatic conditions of Bahawalnagar during kharif 2015

Tr. No.	Treatments	No. of bolls plant^{-1}		Boll weight(g)		Yield (kg ha^{-1})	
		MNH-886	FH-142	MNH-886	FH-142	MNH-886	FH-142
T1	Recommended NPK 340-114-92 kg ha-1	16.2c	17.6c	2.54b	2.68c	1877F	1889E
T2	Recommended NPK + Zn(7.5 kgha-1)+B 7.5 kgha-1+Fe(5 kgha-1)	19.4b	21.6b	2.62a	2.81b	1933D	1969C
T3	Recommended NPK + Zn(7.5 kgha-1)+B 7.5 kgha-1+Fe(5 kgha-1) +Cu(2.5 kg ha-1).	23.2a	24.8b	2.88a	3.08b	2014B	2052A
	LSD	1.11		0.07		11.34	

Means not sharing a common letter in column are significant at 5% probability level.

Maximum seed cotton yield (2052kg ha^{-1}) during kharif 2015 (table 1) was obtained from recommended NPK + Zn(7.5 kgha-1)+B 7.5 kgha-1+Fe(5 kgha-1) +Cu(2.5 kg ha-1) with FH-142 followed by seed cotton yield 2014 kg/ha from MNH-886 as against the minimum seed cotton yield of 1889 and 1877 kg/ha obtained from recommended NPK 340-114-92 kg ha-1

.The similar trend was observed with respect to boll weight and no. of bolls /plant during 2015..The data indicated significant relationship (R2=0.96,0.94) among boll weight and seed cotton yield for MNH-886 and FH-142, respectively (Fig.1).

Different NPK application with micronutrients also influenced number of bolls and boll weight and seed cotton yield significantly ($p<0.05$) during 2016. The results in Table 2behaved similarly with the results of Kharif 2015 and depictedthatT3i.e. recommended NPK + Zn(7.5 kgha-1)+B 7.5 kgha-1+Fe(5 kgha-1) +Cu(2.5 kg ha-1) proved to be better in seed cotton yield(2301 kg/ha) , number of bolls/plant(26.2) and boll weight(3.11 g) with FH-142 followed by the seed cotton yield of 2245 kg ha-1, no of boll.25.2/plant and boll weight 2.88 g in the T1 for MNH-886 as against the minimum seed cotton yield 0f 2018 kg ha-1, number of bolls 19.2/plant and boll weight 2.62 g with T1 for FH-142. Almost similar trend was noted for MNH-886 which yielded lesser than FH-142. The results of Kharif 2016 were proved to better than Kharif 2015. Significant relationship (R2=0.97,0.94) was revealed between boll weight and seed cotton yield for MNH-886 and FH-142, respectively (Fig.2)elucidated that seed cotton yield was linearly increased with increase in boll weight. The same trend of results was observed in case of T2 and T3 except in T1(Table 3) where number of bolls per plant, boll weight and seed cotton yield differed non significantly with respect to MNH-886 and FH-142 where recommended NPK 340-114-92 kg ha-1 was used. For sustainable production, cotton producers may need to change traditional soil fertility programs to an integrated system consisting of macro and micronutrients. The results are in agreement with Ahmad et al, 2011, Ravikiran et al. (2012)Ahmad etal 2016 ,Cioroi and Florea, 2003 and Mousavi, 2011 who concluded that deficiency in any single micronutrient may hamper plant growth and subsequently seed cotton yield.

TABLE 2: Effect of integrated use of macro and micronutrients on the seed cotton yield in the agro-climatic conditions of Bahawalnagar during kharif 2016

Tr. No.	Treatments	No. of bolls $plant^{-1}$		Boll weight(g)		Yield (kg ha^{-1})	
		MNH-886	FH-142	MNH-886	FH-142	MNH-886	FH-142
T1	Recommended NPK 340-114-92 kg ha-1	18.6E	19.2D	2.56C	2.62C	2005F	2018E
T2	Recommended NPK + Zn(7.5 kgha-1)+B 7.5 kgha-1+Fe(5 kgha-1)	22.6C	24.8B	2.72C	2.85B	2141D	2180C
T3	Recommended NPK + Zn(7.5 kgha-1)+B 7.5 kgha-1+Fe(5 kgha-1) +Cu(2.5 kg ha-1).	25.2B	26.2A	2.88B	3.11A	2245B	2301A
	LSD	0.92		0.11		14.52	

Means not sharing a common letter in column are significant at 5% probability level.

TABLE 3: Average effect of integrated use of macro and micronutrients on the seed cotton yield in the agro-climatic conditions of Bahawalnagar during kharif2015 and2016

Tr. No.	Treatments	No. of bolls plant-1		Boll weight(g)		Yield (kg ha-1)	
		MNH-886	FH-142	MNH-886	FH-142	MNH-886	FH-142
T1	Recommended NPK 340-114-92 kg ha-1	17.4D	18.4D	2.55C	2.65C	1941E	1953E
T2	Recommended NPK + Zn(7.5 kgha-1)+B 7.5 kgha-1+Fe(5 kgha-1)	21C	23.2B	2.67C	2.83B	2037D	2074C
T3	Recommended NPK + Zn(7.5 kgha-1)+B 7.5 kgha-1+Fe(5 kgha-1) +Cu(2.5 kg ha-1).	24.2B	25.5A	2.88B	3.09A	2129B	2176A
	LSD	1.17		0.14		18.67	

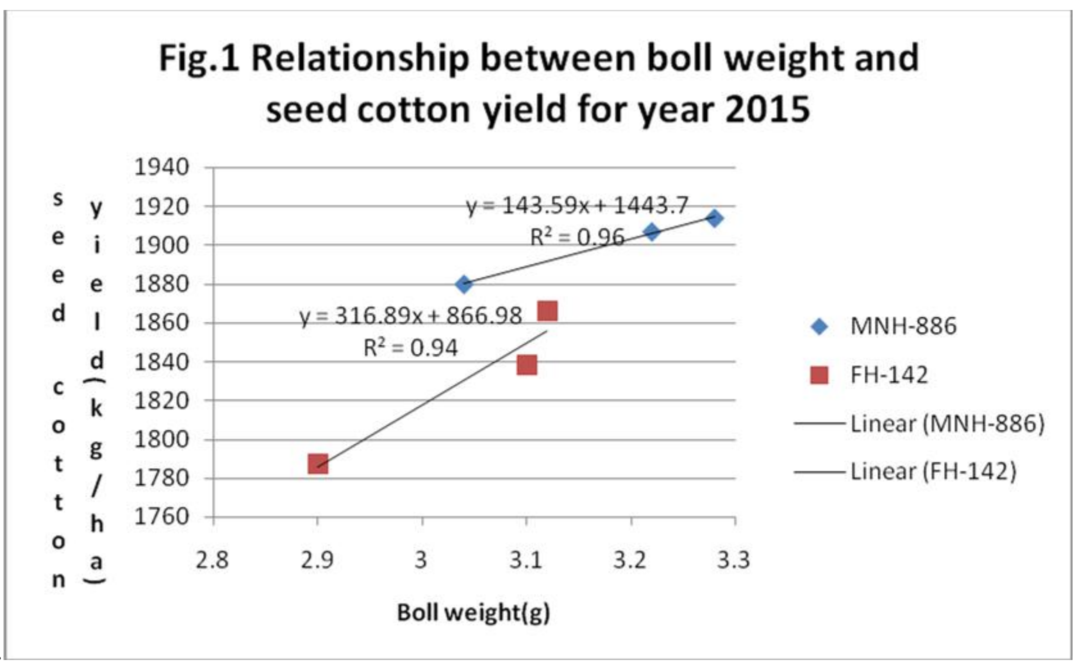
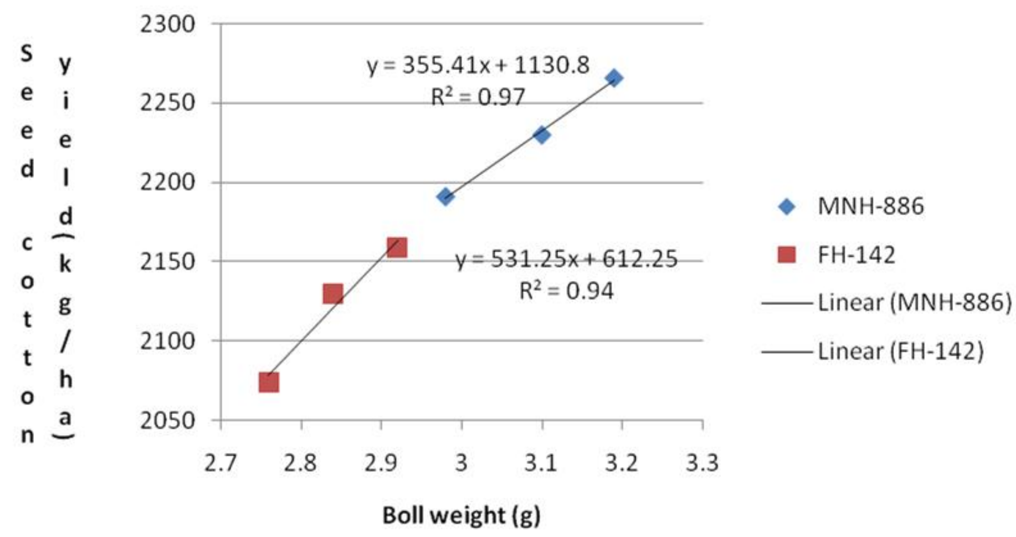


Fig. 2 Relationship between boll weight and seed cotton yield for year 2016



Conclusion

This study revealed that judicious and balanced use of micro and macronutrients in Bt-cotton substantially improved the number of bolls per plant and seed cotton yield. The results also showed that the combination of boron and zinc, iron and copper (B 7.5 kgha+ Zn(7.5 kgha-1)+ Fe(5 kgha-1) +Cu(2.5 kg ha-1)., respectively) along with recommended NPK significantly increased the yield and yield components of cotton than recommended NPK applications alone. Increase in boll weight was mainly due to translocation of various metabolites such as sugar, cellulose, etc. triggered by the enzymatic activation for increased photosynthetic efficiency which leads to increase in seed cotton yield.

References

1. Abid M, Ahmed N, Ali A, Chaudhry MA, Hussain J. Influence of soil-applied boron on yield, fiber quality and leaf boron contents of cotton (*Gossypium hirsutum* L.). J Agric Social Sci 2007; 3:7–10.
2. Ahmad, M. 1*, M. Jamil1, Z. Ahmad, M. A.Kharal, A.Niaz, M.Iqbal, M. F.Akhtar, M.Latif2016.Improving the Productivity of Bt Cotton (*Gossypium hirsutum* L.) Through Integrated Plant Nutrient Management. Science Letters 2016 | Volume 4 | Issue 1 | Pages 44-50
3. Ahmed N., M. Abid, F. Ahmad, M. Amanullah, Q. Javaid and M. Arif.2011. Impact of boron fertilization on dry matter production and Mineral constitution of irrigated cotton. Pak. J. Bot., 43(6): 2903-2910.
4. Ahmed, N., M. Abid and F. Ahmad. 2008. Boron toxicity in irrigated cotton (*Gossypium hirsutum* L.). Pak J. Bot., 40:2442-2452.
5. Ahmed, A.U.H., R.Ali, S.I Zamir and N.Mahmood. 2009. Growth, yield and qualityperformance of cotton cultivars BH-160 *Gossypium hirsutum* L.) as influenced by different plant spacing. JAPS, 19:189-192.
6. Ajouri, A., Asgedom, H. and Becker, M. Seed priming enhances germination and seedling growth of barley under conditions of P and Zn deficiency. Journal of Plant Nutrition and Soil Science, 2004; 167: 630-636. http://dx.doi.org/10.1002/jpln.200420425
7. Anonymous (2001) Agricultural Statistics of Pakistan. Ministry of Food, Agriculture and Livestock (MINFAL), Islamabad, Pakistan, pp 12–13
8. Anonymous. 1998. Micronutrients in agriculture. Pakistan perspective. National Fertilizer Development Center,Islamabad, Pakistan. p. 1-51.
9. Ashraf Abd El-AalaAbd El-Mohsen, Mohammed Abd El-Azim Ahmed. 2015. The effect of applying different fertilizer regimes on productivity and profitability of Egyptian cotton under middle Egypt

conditions. Advance in Agriculture and Biology, **4:** 31–38.
a.Basic and Applied Sciences, 2011; 5(9): 1503-1509.

10. Bisson, P., M. Cretenet and E. Jallas. 1994. Nitrogen, phosphorous and potassium availability in the soil, physiology of assimilation and use of these nutrients by the plant. Proceeding World Cotton Research Conference, **1:** 115–124.
11. Brady, N.C. 1984. The Nature and Properties of Soils. Macmillan Publishing Inc. New York, USA.
12. Cioroi, M. and Florea. T. The study of manganese content in soil, wheat grain and wheat plants. Ovidius University Annals of Chemistry, 2003;14(1): 9-11.
13. Crozier CR, B Walls, DH Hardy, JS Barnes (2004) Response of Cotton to P and K Soil Fertility Gradients in North Carolina. Journal Cotton Science, **8:** 130–141.
14. Fageria, N.K., V.C. Baligar and R.B. Clark. 2002. Micronutrients in crop production. Adv. Agron.,77: 185-268.
15. Gerik TJ, BS Jackson, CO Stockle, WD Rosenthal (1994) Plant nitrogen status and boll load of cotton. Agronomy Journal, **86:** 514–518.
16. Imtiaz, M., A. Rashid, P. Khan, M.Y. Memon and M. Aslam.2010 The role of micronutrients in crop production and human health. Pak. J. Bot., 42: 2565-2578.
17. Ali L, Ali M, Mohyuddin Q. Effect of foliar application of zinc and boron on seed cotton yield and economics in cotton-wheat cropping pattern. J Agric Res 2011; 49(2):173-180.
18. Mousavi, S.R. Zinc in Crop Production and Interaction with Phosphorus. Australian Journal of Basic and Applied Sciences, 2011; 5(9): 1503-1509.
19. Pettigrew WT (2003) Relationships between insufficient potassium and crop maturity in cotton. Agronomy Journal, **95:** 1323–1329.
20. Ravikiran, S., A. S. Halepyati, B. T. Pujari, B. G. Koppalakar and K. NarayanaRao. 2012.Effect of macro and soluble micronutrients on yield, uptake of nutrients, quality and economics of Bt cotton (*Gossypium hirsutum*L.) under irrigation* Karnataka J. Agric. Sci.,25 (4) : (418-422) 2012
21. Singh K, Rathore P, Gumber RK. Effects of foliar application of nutrients on growth and yield of Bt cotton (*Gossypium hirsutum*L.). Bangl J Bot 2015; 44:9-14.
22. Tariq, M. and C.J.B. Mott. 2007. Effect of boron on the behaviour of nutrients in soil –plant systems-A review.Asian J. Plant Sci., 6: 195-202.
23. Timmer, V.R. and Teng, Y. Phosphorus-induced micronutrient disorders in hybrid popular. Responses to zinc and copper in greenhouse culture. Plant and Soil, 1990; 126(1): 31-39. http://dx.doi.org/10.1007/BF00041366
24. Wahhab A (1985) Crop response to fertilizer and soil data interpretation. FAO Project NFDC/069/ Pakistan
25. Wang, H.X., Wu, J.L., Zhang, T.J., Wu, O.X.,Chen, Y., Bian, J.S. and Shaan, F. Study on interaction between P and Zn and their influence on the growth of maize seedlings in calcareous soils. Acta Pedologica Sinica, 1990; 27(3): 241-249.

Access this Article in Online	
	Website: www.ijarm.com
Quick Response Code	Subject: Agricultural Sciences
DOI:10.22192/ijamr.2018.05.11.005	

How to cite this article:
Liaqat Ali, M. Akram, Mueenud Din, Ubaidur Rehman, M. Zafar, Abdul Ghafoor and Zafar Yab Haider. (2018). Improving the productivity of cotton (*Gossypium hirsutum* L.) by integrated use of macro and micronutrients under agro-climatic conditions of Bahawalnagar, Pakistan. Int. J. Adv. Multidiscip. Res. 5(11): 37-43.
DOI: http://dx.doi.org/10.22192/ijamr.2018.05.11.005