Journal of Biology, Agriculture and Healthcare
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online)
Vol.5, No.19, 2015 www.iiste.org

Effect of Zinc and Boron in Combination with NPK on Sunflower (Helianthus annuus L.) Growth and Yield

Rafique Ahmed Baloch[1] Sana Ullah Baloch[2] Shahbaz Khan Baloch[2] Allah Bakhsh Baloch[3]
Hafeez Noor Baloch[4] Waseem Bashir[4] Shahab-u-din Kashani[4] Zahid Saeed[3] Muslim Baloch[1]
Waseem Akram[4] Shabeer Ahmed Badini[1] Muzaffar Ahmed[1] A.Shakoor Ruk[4]
1. Department of Agriculture Research, Balochistan, Pakistan
2. College of Plant Science and Technology, Huazhong Agricultural University, Wuhan 430071, Hubei, China.
3. Department of Agriculture Extension, Balochistan, Pakistan
4. Department of Agronomy and Faculty of Crop Production, Sindh Agriculture University, Tandojam, Pakistan

Abstract

A field study was undertaken at Oilseed Section, Agriculture Research Institute, Tandojam during autumn 2013 to evaluate the effect of zinc and boron in combination with NPK on sunflower growth and yield. The experiment was laid out in a three replicated randomized complete block design. The treatments comprised of: 90-45-45 NPK kg/ha^{-1}, NPK + 10 + 1.5 Zn + B kg/ha^{-1}, NPK + 15 + 1.5 Zn + B kg/ha^{-1}, NPK + 15 + 2.0 Zn + B kg/ha^{-1} and NPK + 20 + 1.5 Zn + B kg/ha^{-1}. The results showed that zinc, boron and NPK in combination with each other caused significant ($P<0.05$) effect on growth and yield traits of sunflower variety HO-1. The plots receiving NPK + 20 + 1.5 Zn + B kg/ha^{-1} produced maximum plant height (160.6 cm), stem girth (3.6 cm), head diameter (20.4 cm), seeds per head (1255.3), seed weight (60.9 g head^{-1}), seed index (1000-seed weight: 64.8 g) and seed yield (2386.0 kg/ha^{-1}), closely followed by plots fertilized with NPK + 15 + 2.0 Zn + B kg/ha^{-1} resulting in 157.8 cm plant height, 3.4 cm stem girth, 18.6 cm head diameter, 1189.3 seeds per head, 53.3 g head^{-1} seed weight, 62.9 g seed index (1000-seed weight) and 2314.0 kg/ha^{-1} seed yield whereas, NPK + 15 + 1.5 Zn + B kg/ha^{-1} ranked 3rd with 153.8 cm plant height, 3.3 cm stem girth, 17.8 cm head diameter, 1150.0 seeds per head, 57.3 g head^{-1} seed weight, 62.3 g seed index (1000-seed weight) and 2277.7 kg/ ha^{-1} seed yield. However, minimum plant height (144.1 cm), stem girth (3.0 cm), head diameter (16.2 cm), seeds per head (1013.0), seed weight (46.7 g head-1), seed index (1000-seed weight: 57.6 g) and seed yield (2030.7 kg/ha^{-1}) was observed in plots where 90-45-45 NPK kg/ha^{-1} (Control) was applied. Hence, results indicated that application of micronutrients (zinc and boron) in combination with macro-nutrients (NPK) enhanced the growth and yield performance of sunflower. Although at higher doses of Zn and B numerically higher yield was noted but application of NPK + 15 + 1.5 Zn + B kg/ha^{-1} showed non-significant differences with NPK + 20 + 1.5 Zn + B kg/ha^{-1} and NPK + 15 + 2.0 Zn + B kg/ha^{-1} almost in all the growth and yield parameters, particularly seed yield.
Keywords: Sunflower, Zinc, Boron, NPK, growth and yield

Introduction

Sunflower (*Helianthus annuus* L.) is a short duration, high yielding and non-conventional oilseed crop that fits well in existing cropping systems and can be grown without replacing any major crop. Sunflower farming has been practiced for a long time in many parts of the world, including Pakistan aiming at increasing oil production. Smallholder sunflower crop farming is an important sector that produces and nourishes rural as well as urban and peri-urban people with quality oil, which is free from cholesterol (Munir et al., 2007).

Sunflower has the potential to bridge up the gap between demand and supply of edible oil and it is well adapted to agro-ecological conditions of Pakistan (Ali et al., 2012). At present, the total requirement of edible oil in the country is 2.045 million tons. During the year 2010-11, the total availability of edible oil was 3.079 million tons; of which local production contributed 0.696 million tons (34 percent of the requirement); while imports of edible oil or oilseeds was 2.383 million tons and the import bill reached Rs. 224 billion in 2010-11 (GOP, 2012). The average seed yield of sunflower per hectare is far less than the existing varietal potential. The potential of any variety can only be fully exploited by the judicious use of inputs at proper growth stages (Baniabbass et al., 2012).

Sunflower crop responds positively to management factors and overall yield is correlated with nutrient uptake throughout its growth period. Nutrients play an important role in crop growth and development. Micronutrients play a major role in increasing seed setting percentage and influence growth and yield. Among the micronutrients, boron and zinc play an important role in seed setting and yield of sunflower. Boron can influence photosynthesis and respiration and activate number of enzymatic systems of protein and nucleic acid metabolism in plants (Chowdhury et al., 2010). Zinc deficiency is one of the most widespread micronutrient deficiencies in Pakistan as a result of the alkaline soil condition. So, it is very important to apply zinc fertilizer for increasing crop yields and improving crop quality. Zinc also plays an important role in the production of biomass (Cakmak, 2008). In addition, Zn plays other indirect and significant roles as stabilizer of proteins, membranes, and DNA-binding proteins such as Zn-fingers (Aravind and Prasad, 2003). Furthermore, zinc may be required for chlorophyll production, pollen function and fertilization (Pandey et al., 2006). Zinc is required for the bio-synthesis of the plant growth regulator such as indole-3-acetic acid (IAA) (Fang et al., 2008), and for carbohydrate and N metabolism which leads to high yield and yield components.

Among the macronutrients, NPK are the major nutrients that enhance the metabolic processes that based on protein, leads to increases in vegetative, reproductive growth and yield of the crops. With the increasing rates of nitrogen, growth, achene yield and overall achene oil yield per unit area increased (Chkerol, 2006). Malik et al. (2006) concluded that different combinations of NPK had significantly affected achene yield and oil content. Nasim et al. (2011) concluded that with the increase of nitrogen level, there is increment in the yield and yield components of sunflower. Phosphorus is an essential element for reproductive plant organs as well as inflorescence, grain formation and ripening. Jahangir et al. (2006) found that maximum number of seeds per head and yield were produced by the application of 75 kg P2O5 per hectare. Osman and Awed (2010) demonstrated that increasing nitrogen and phosphorus levels increased growth and yield in sunflower.

Study Area

The study was carried out in Sindh Agriculture University, Tandojam. Located in the extreme south of Pakistan, is situated in Tandojam town at 18 km from Hyderabad, on Hyderabad-Mirpurkhas highway and is about 200 km from Karachi airport linked with super highway to Hyderabad, Pakistan.

1.1 MATERIALS AND METHODS

The field study was conducted at Oilseeds Section, Agriculture Research Institute, Tandojam during autumn 2013. The experiment was laid out in a three replicated randomized complete block design (RCBD), having net plot size 6 m x 4 m (24 m2). The seed of sunflower cultivar HO-1 was used throughout the experiment. The sowing was done on 1st September, 2013. The fertilizers were applied as per treatments schedule. Nitrogen, Phosphorus, Potassium, Boron and Zinc were applied in the form of Urea, DAP, SOP, Borax and ZnSO4. Full dose of P, K, B, Zn and half dose of N were applied at the time of sowing whereas, remaining half of N was applied at the time of 1st irrigation. The details of treatments are as under:

Treatments = 5

T1 = 90-45-45 NPK kg/ha^{-1} (Control)
T2 = NPK + 10 + 1.5 Zn + B kg/ha^{-1}
T3 = NPK + 15 + 1.5 Zn + B kg/ha^{-1}
T4 = NPK + 15 + 2.0 Zn + B kg/ha^{-1}
T5 = NPK + 20 + 1.5 Zn + B kg/ha^{-1}

Observations recorded

1. Plant height (cm)
2. Stem girth (cm)
3. Head diameter (cm)
4. Seeds per head
5. Seed weight (g head-1)
6. Seed index (1000 seed-weight, g)
7. Seed yield (kg ha-1)

Statistical Analysis

The collected data were subjected to statistical analysis using statistics 8.1 computer software (statistics, 2006). The LSD test was applied to compare treatments superiority, where necessary.

RESULTS

The field study was conducted at Oilseeds Section, Agriculture Research Institute, Tandojam during autumn 2013. The experiment was laid out in a three replicated randomized complete block design (RCBD), having net plot size 6 m x 4 m (24 m2). The seed of sunflower cultivar HO-1 was used throughout the experiment. The sowing was done on 1st September, 2013. The fertilizers were applied as per treatments schedule. Nitrogen, Phosphorus, Potassium, Boron and Zinc were applied in the form of Urea, DAP, SOP, Borax and ZnSO4. Full dose of P, K, B, Zn and half dose of N were applied at the time of sowing whereas, remaining half of N was applied at the time of 1st irrigation. The treatments comprised of: 90-45-45 NPK kg ha-1, NPK + 10 + 1.5 Zn + B kg ha-1, NPK + 15 + 1.5 Zn + B kg ha-1, NPK + 15 + 2.0 Zn + B kg ha-1 and NPK + 20 + 1.5 Zn + B kg ha-1. The data were collected on parameters of economic importance such as plant height (cm), stem girth (cm), head diameter (cm), seeds per head, seed weight (g head-1), seed index (1000-seed weight, g) and seed yield (kg ha-1). This chapter contains the data for the above parameters (Tables 1-7), while the analysis of variance as Appendix I to VII.

Plant Height (cm)

The results regarding plant height (cm) of sunflower as influenced by integrated application of Zn, B and NPK are presented in Table-1. The results showed that application of Zn and B significantly ($P<0.05$) affected plant height of sunflower variety HO-1. It is evident from the data that tallest plants (160.6 cm) were observed in plots fertilized with NPK + 20 + 1.5 Zn + B kg ha-1, closely followed by plots fertilized with NPK + 15 + 2.0 Zn + B kg ha-1 and NPK + 15 + 1.5 Zn + B kg ha-1 which produced 157.8 and 153.8 cm tall plants, respectively. The plants with the height of 151.4 were noted in plots fertilized with NPK + 10 + 1.5 Zn + B kg ha-1. However, the smallest plants (144.1 cm) were noticed in plots supplied with 90-45-45 NPK kg ha-1 (Control). The results further showed that statistically, NPK + 20 + 1.5 Zn + B kg ha-1, NPK + 15 + 2.0 Zn + B kg ha-1 and NPK + 15 + 1.5 Zn + B kg ha-1 differed non-significantly (P>0.05) with each other for plant height.

Table 1. Plant height (cm) of sunflower under the effect of Zn, B and NPK

Treatments	Mean
90-45-45 NPK kg/ha^{-1} (Control)	144.1 B
NPK + 10 + 1.5 Zn + B kg/ha^{-1}	151.4 AB
NPK + 15 + 1.5 Zn + B kg/ha^{-1}	153.8 A
NPK + 15 + 2.0 Zn + B kg/ha^{-1}	157.8 A
NPK + 20 + 1.5 Zn + B kg/ha^{-1}	160.6 A

S.E.± = 4.0951
LSD 0.05 = 9.4432
LSD 0.01 =

Stem Girth (cm)

The results pertaining to stem girth (cm) of sunflower as affected by combined application of Zn, B and NPK are shown in Table-2. The data illustrated that application of Zn and B significantly (P<0.05) affected stem girth of sunflower variety HO-1. It is apparent from the results that maximum stem girth (3.6 cm) was recorded in plots supplied with NPK + 20 + 1.5 Zn + B kg ha-1, closely followed by plots applied with NPK + 15 + 2.0 Zn + B kg ha-1 and NPK + 15 + 1.5 Zn + B kg ha-1 which resulted in 3.4 and 3.3 cm stem girth, respectively. The stem girth of 3.1 cm was observed in plots fertilized with NPK + 10 + 1.5 Zn + B kg ha-1. However, the minimum (3.0 cm) stem girth was registered in plots applied with 90-45-45 NPK kg ha-1 (Control). Moreover, statistically NPK + 20 + 1.5 Zn + B kg ha-1, NPK + 15 + 2.0 Zn + B kg ha-1 and NPK + 15 + 1.5 Zn + B kg ha-1 showed non-significant (P>0.05) differences with each other for stem girth.

Table 2. Stem Girth (cm) of sunflower under the effect of Zn, B and NPK

Treatments	Mean
90-45-45 NPK kg/ha^{-1} (Control)	3.0 D
NPK + 10 + 1.5 Zn + B kg/ha^{-1}	3.1 CD
NPK + 15 + 1.5 Zn + B kg/ha^{-1}	3.3 BC
NPK + 15 + 2.0 Zn + B kg/ha^{-1}	3.4 B
NPK + 20 + 1.5 Zn + B kg/ha^{-1}	3.6 A

S.E.± = 0.0767
LSD 0.05 = 0.1770
LSD 0.01 = 0.2575

Head Diameter (cm)

The data relating to head diameter (cm) of sunflower as affected by integrated application of Zn, B and NPK are presented in Table-3. The results suggested that application of Zn and B significantly (P<0.05) affected head diameter of sunflower variety HO-1. It is clear from the data that maximum head diameter (20.4 cm) was noted in plots fertilized with NPK + 20 + 1.5 Zn + B kg ha-1, closely followed by plots supplied with NPK + 15 + 2.0 Zn + B kg ha-1 and NPK + 15 + 1.5 Zn + B kg ha-1 which produced 18.6 and 17.8 cm head diameter, respectively. The head diameter of 16.6 cm was noted in plots fertilized with NPK + 10 + 1.5 Zn + B kg ha-1. However, the minimum (16.2 cm) head diameter was seen in plots applied with 90-45-45 NPK kg ha-1 (Control). Furthermore, statistically NPK + 20 + 1.5 Zn + B kg ha-1, NPK + 15 + 2.0 Zn + B kg ha-1 and NPK + 15 + 1.5 Zn + B kg ha-1 showed non-significant (P>0.05) differences with each other for head diameter.

Table 3. Head diameter (cm) of sunflower under the effect of Zn, B and NPK

Treatments	Mean
90-45-45 NPK kg/ha^{-1} (Control)	16.2 D
NPK + 10 + 1.5 Zn + B kg/ha^{-1}	16.6 D
NPK + 15 + 1.5 Zn + B kg/ha^{-1}	17.8 C
NPK + 15 + 2.0 Zn + B kg/ha^{-1}	18.6 B
NPK + 20 + 1.5 Zn + B kg/ha^{-1}	20.4 A

S.E.±= 0.2919
LSD 0.05 = 0.6732
LSD 0.01 = 0.9795

Seeds Per head

The results regarding seeds per head of sunflower as affected by integrated application of Zn, B and NPK are presented in Table-4. The results showed that application of Zn and B significantly (P<0.05) affected head diameter of sunflower variety HO-1. It is evident from the results that maximum seeds per head (1255.3) were recorded in plots fertilized with NPK + 20 + 1.5 Zn + B kg ha-1, closely followed by plots supplied with NPK + 15 + 2.0 Zn + B kg ha-1 and NPK + 15 + 1.5 Zn + B kg ha-1 which produced 1189.3 and 1150.0 seeds per head, respectively. The 1038.0 seeds per head were noted in plots fertilized with NPK + 10 + 1.5 Zn + B kg ha-1. However, the minimum (1013.0) seeds per head were noticed in plots applied with 90-45-45 NPK kg ha-1 (Control). Moreover, statistically NPK + 20 + 1.5 Zn + B kg ha-1, NPK + 15 + 2.0 Zn + B kg ha-1 and NPK + 15 + 1.5 Zn + B kg ha-1 indicated non-significant (P>0.05) differences with each other for seeds per head.

Table 4. Seeds per head of sunflower under the effect of Zn, B and NPK

Treatments	Mean
90-45-45 NPK kg/ha^{-1} (Control)	1013.0 C
NPK + 10 + 1.5 Zn + B kg/ha^{-1}	1038.0 C
NPK + 15 + 1.5 Zn + B kg/ha^{-1}	1150.0 B
NPK + 15 + 2.0 Zn + B kg/ha^{-1}	1189.3 B
NPK + 20 + 1.5 Zn + B kg/ha^{-1}	1255.3 A

S.E.±= 24.844
LSD 0.05 = 57.289
LSD 0.01 = 83.360

Seed weight/g head^{-1}

The results pertaining to seed weight (g head-1) of sunflower as affected by combined application of Zn, B and NPK are shown in Table-5. The data illustrated that application of Zn and B significantly (P<0.05) affected to seed weight (60.9 g head-1) of sunflower variety HO-1. It is apparent from the results that maximum seed weight (53.3 g head-1) was recorded in plots supplied with NPK + 20 + 1.5 Zn + B kg ha-1, closely followed by plots applied with NPK + 15 + 2.0 Zn + B kg ha-1 and NPK + 15 + 1.5 Zn + B kg ha-1 which resulted in 57.3 and 48.8 g head-1 seed weight, respectively. The seed weight of 95.0 g head-1 was observed in plots fertilized with NPK + 10 + 1.5 Zn + B kg ha-1. However, the minimum (46.7 g head-1) seed weight was registered in plots applied with 90-45-45 NPK kg ha-1 (Control). Moreover, statistically NPK + 20 + 1.5 Zn + B kg ha-1, NPK + 15 + 2.0 Zn + B kg ha-1 and NPK + 15 + 1.5 Zn + B kg ha-1 showed non-significant (P>0.05) differences with each other for seed weight (g head-1).

Table 5. Seed weight (g head^{-1}) of sunflower under the effect of Zn, B and NPK

Treatments	Mean
90-45-45 NPK kg/ha^{-1} (Control)	46.7 D
NPK + 10 + 1.5 Zn + B kg/ha^{-1}	48.8 D
NPK + 15 + 1.5 Zn + B kg/ha^{-1}	57.3 C
NPK + 15 + 2.0 Zn + B kg/ha^{-1}	53.3 B
NPK + 20 + 1.5 Zn + B kg/ha^{-1}	60.9 A

S.E.± = 1.5340
LSD 0.05 = 3.5374
LSD 0.01 = 5.1471

Seed index (1000-seed weight, g)

The data relating to seed index (1000-seed weight, g) of sunflower as affected by integrated application of Zn, B and NPK are presented in Table-6. The results suggested that application of Zn and B significantly (P<0.05) affected head diameter of sunflower variety HO-1. It is clear from the data that maximum seed index (1000-seed weight (64.8 g) was noted in plots fertilized with NPK + 20 + 1.5 Zn + B kg ha-1, closely followed by plots supplied with NPK + 15 + 2.0 Zn + B kg ha-1 and NPK + 15 + 1.5 Zn + B kg ha-1 which produced 62.9 and 62.3 g seed index (1000-seed weight, respectively. The seed index (1000-seed weight) of 58.1 g was noted in plots fertilized with NPK + 10 + 1.5 Zn + B kg ha-1. However, the minimum (57.6 g) seed index (1000-seed weight) was observed in plots applied with 90-45-45 NPK kg ha-1 (Control). Furthermore, statistically NPK + 20 + 1.5 Zn + B kg ha-1, NPK + 15 + 2.0 Zn + B kg ha-1 and NPK + 15 + 1.5 Zn + B kg ha-1 showed non-significant (P>0.05) differences with each other for seed index (1000-seed weight, g).

	

Table 6. Seed index (1000-seed weight, g) of sunflower under the effect of Zn, B and NPK

Treatments	Mean
90-45-45 NPK kg/ha^{-1} (Control)	57.6 C
NPK + 10 + 1.5 Zn + B kg/ha^{-1}	58.1 C
NPK + 15 + 1.5 Zn + B kg/ha^{-1}	62.3 B
NPK + 15 + 2.0 Zn + B kg/ha^{-1}	62.9 B
NPK + 20 + 1.5 Zn + B kg/ha^{-1}	64.8 A

S.E.± = 0.6616
LSD 0.05 = 1.5256
LSD 0.01 = 2.2198

Seed Yield (kg/ha^{-1})

The results pertaining to seed yield (kg ha-1) of sunflower as affected by combined application of Zn, B and NPK are shown in Table-5. The data illustrated that application of Zn and B significantly (P<0.05) affected seed yield (kg ha-1) of sunflower variety HO-1. It is clear from the results that maximum seed yield (2386.0 kg ha-1) was recorded in plots supplied with NPK + 20 + 1.5 Zn + B kg ha-1, closely followed by plots applied with NPK + 15 + 2.0 Zn + B kg ha-1 and NPK + 15 + 1.5 Zn + B kg ha-1 which resulted in 2314.0 and 2277.7 kg ha-1 seed yield, respectively. The seed yield of 2210.0 kg ha-1 was observed in plots fertilized with NPK + 10 + 1.5 Zn + B kg ha-1. However, the minimum (2030.7 kg ha-1) seed yield was recorded in plots applied with 90-45-45 NPK kg ha-1 (Control). Moreover, statistically NPK + 20 + 1.5 Zn + B kg ha-1, NPK + 15 + 2.0 Zn + B kg ha-1 and NPK + 15 + 1.5 Zn + B kg ha-1 showed non-significant (P>0.05) differences with each other for seed yield (kg ha-1).

Table 7. Seed yield (kg/ha^{-1}) of sunflower under the effect of Zn, B and NPK

Treatments	Mean
90-45-45 NPK kg/ha^{-1} (Control)	2030.7 C
NPK + 10 + 1.5 Zn + B kg/ha^{-1}	2210.0 B
NPK + 15 + 1.5 Zn + B kg/ha^{-1}	2277.7 AB
NPK + 15 + 2.0 Zn + B kg/ha^{-1}	2314.0 AB
NPK + 20 + 1.5 Zn + B kg/ha^{-1}	2386.0 A

S.E.± = 60.383
LSD 0.05 = 139.24
LSD 0.01 = 202.61

1.1.2 DISCUSSION

The major reason of lower yield than its yield potential is lack of production technology, particularly imbalanced use of fertilizers. Sunflower crop responds positively to management factors and overall yield is correlated with nutrient uptake throughout its growth period. Nutrients uptake begins soon after germination of sunflower seedlings. An uptake of these nutrient elements is in low amounts at early stage of planting but as the plants continues to grow their need for the nutrient raises. Phosphorus and nitrogen that help improving germination of root system and vegetation are major nutrients but the necessity of some other trace elements is also as important as macro as they also contribute in several metabolic processes and are critical for rice plants survival.

Micronutrient deficiencies are not only hampering crop productivity but also are deteriorating produce quality. The low micronutrient foods and food stuffs are causing health hazards in human beings and animals. Micronutrient acts as catalyst in the uptake and use of certain macronutrients. Seed size and quality as well as produce quality of some crops, are improved with micronutrients use. Recent studies indicated that the soils also have become inadequate in various micronutrients including zinc (Maqsood et al. 2009). Zn is known to have an important role either as a metal component of enzymes or as a functional, structural or regulatory cofactor of a large number of enzymes (Grotz and Guerinot, 2006). Zinc also plays an important role in the production of biomass. It is required for chlorophyll production, pollen function and fertilization (Kaya and Higgs, 2002). The application of micronutrients, particularly zinc and boron plays very important role in quantitative and qualitative development of the plants (Asad and Rafique, 2000). The supply of zinc and boron to crop at proper growth stage in optimum quantity also plays very crucial role in enhancing crop yield.

The study showed the effectiveness of boron and zinc for improving growth and yield of sunflower in conjunction with recommended dose of NPK fertilizer. The best performance of sunflower variety HO-1 was obtained with application of NPK + 20 + 1.5 Zn + B kg ha-1 resulted in maximum plant height (160.6 cm), stem girth (3.6 cm), head diameter (20.4 cm), seeds per head (1255.3), seed weight (60.9 g head-1), seed index (1000-seed weight: 64.8 g) and seed yield (2386.0 kg ha-1), closely followed by plots receiving NPK + 15 + 2.0 Zn + B kg ha-1 which produced 157.8 cm plant height, 3.4 cm stem girth, 18.6 cm head diameter, 1189.3 seeds per head, 53.3 g head-1 seed weight, 62.9 g seed index (1000-seed weight) and 2314.0 kg ha-1 seed yield. The results of this research are in agreement with the findings of Nasim et al. (2012) who reported that nitrogen @ 180 kg ha–1 gave maximum TDM (17890 kg ha–1) and seed yield (3809 kg ha–1) of sunflower compared to the other N rates. The results of this study indicated that application of micronutrients (zinc and boron) in combination with macro-nutrients (NPK) enhanced the growth and yield performance of sunflower. Although at higher doses of Zn and B numerically higher yield was noted but application of NPK + 15 + 1.5 Zn + B kg ha-1 showed non-significant differences with NPK + 20 + 1.5 Zn + B kg ha-1 and NPK + 15 + 2.0 Zn + B kg ha-1 almost in all the growth and yield parameters, particularly seed yield. Similarly, Ali and Noorka (2013) reported that leaf area plant-1, head diameter, 1000- achene weight and achene yield of sunflower were affected significantly by different nitrogen and phosphorus levels. Interactive effects of nitrogen and phosphorus were significant in all these cases. The highest achene yield (2584 kg ha-1) was obtained with the application of 135-75 kg NP ha-1 as against the lowest (1491kg ha-1) at 85-50 kg NP ha-1. In another study, Madani (2013) revealed that field consumption of 350 kg/ha triple super phosphate and soluble zinc foliar application caused significant increase in seeds weight for oil and nut sunflowers types. The highest sunflower seed number in heads was 2730 kernels by obtained in treatment that received phosphorus alone. The consequences of this study propose that soil application of zinc sulphate may increase grain yield and zinc content in sunflower seed. The results are also in line with those of Khan et al. (2010) who displayed that highest seed yields (2743 kg ha-1) and 1000-seed weight of sunflower were obtained in treatment that received combined application of 10 kg zinc and 5 kg iron ha-1

CONCLUSIONS

The results concluded that application of Zn and B in combination with NPK caused significant effects on growth and yield sunflower variety HO-1. Application of zinc and boron at higher rates produced maximum values for seed yield, but the plots fertilized with NPK + 15 + 1.5 Zn + B kg/ha^{-1} proved to be suitable for obtaining optimum yield of sunflower under agro-ecological conditions of Tandojam due to having non-significant statistical differences with plots which received higher dose of Zn and B.

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