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RESEARCH ARTICLE

Effect of Integrated Nutrients Use on Yield and Quality of Sunflower

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ABSTRACT

A field trial was conducted at the Agronomic Research Area, Department of Agronomy, University of Agriculture, Faisalabad, Pakistan to assess the influence of combined nutrients use on yield and quality of sunflower (*Helianthus annuus* L.)**.** Treatments were i) control;, ii) recommended dose of fertilizer (RDF); iii) single spray of multi nutrients at V_4 stage (four leaves stage); iv) RDF+1 spray of multi nutrients at V_4 stage; v) 2 spray of multi nutrients at V_4 and V_8 stages; vi) RDF+2 spray of multi nutrients at V_4 and V_8 stages; vii) three spray of multi nutrients at V_4, V_8 and V_{12} stages; viii) RDF+ 3 spray of multi nutrients at V_4, V_8 and V_{12} stages. Multi nutrients Zn (4.7%), Mn (2%), Fe (2%), B (1%) and Cu (0.3%) were applied at the rate of 1.25 L/ha. Nitrogen was used in three splits i.e. half at sowing time, 1/4 at 1st irrigation and remaining 1/4 at flowering. While, phosphorus and potassium were used at sowing. Results showed that 1000-achene weight (48.80g), Stem diameter (3.08 cm), number of achene per head (1005.50), head diameter (14.92 cm) and achene yield (2900 kg ha^{-1}) was significantly higher in the treatment (T_8) where RDF +3 sprays of multi nutrients (1.25L/ha at V_4, 1.25L/ha at V_8 and 1.25L/ha at V_{12} stages) were applied. It was concluded that N-P-K at the rate of 110-57-62 kg/ha + three sprays of multi nutrients (Zn 4.7%, Mn 2%, Fe 2%, B 1% and Cu 0.3%) applied at the rate of 1.25 L/ha at V_4 (four true leaves), V_8 (Eight true leaves) and V_{12} (twelve true leaves) stages of sunflower (Hysun 33) gave the best yield under agro-climatic conditions of Faisalabad, Pakistan.

INTRODUCTION

The economy of Pakistan is agriculture based. Accounting for over 21 percent of GDP, it is single largest sector, and regarding total labor of the country, 45 percent of it thrives on agriculture system. In Pakistan sunflower is also oil seed crop with many qualities (Nasim et al., 2011). Among oilseeds, sunflower can never be neglected as it is adapted to environmental conditions of Pakistan and rich in nutritional compounds. Sunflower (*Helianthus annuus* L.) belongs to the family compositae. Sunflower cultivation has become common because of its short duration, photo insensitivity, wide adaptability and drought tolerance (Hegde, 2000). Sunflower is the 4th oil grain crop cultivated globally by area and third major oilseed crop after cottonseed and rapeseed/mustard of Pakistan During the year 2014-15 total availability of edible oil was 3.523 million tonnes. Local production of edible oil contributed 0.556 million tonnes while import of edible oil/oilseeds was 2.967 million tonnes. The edible oil import bill during 2014-15 was Rs.269.412 billion (US$ 2.663 billion) (Anonymous, 2015). Sunflower plays an important role in human diet by producing edible oil. Sunflower oil is a rich source of fatty acids, which act as a reagent in chemical compounds. Sunflower oil has first-rate dietary properties. In Pakistan's economy oilseed crops have vital reputation with reference to agriculture. In oilseed production Pakistan is deficient. At present, estimated production of oilseed is 0.696 million tonnes, which fulfill only 23% requirement of domestic use while remaining 77% is being fulfilled through import, due to which Pakistan has become a third key importer

country of edible oil in the world. During 2015-16 (July-March), 2.205 million tonnes edible oil of value Rs.136.920 billion (US$ 1.392 billion) was imported showing an increase of 24.5 percent against the same period 2014-15 (Anonymous, 2015). It is especially free from any type of toxic compound and has relatively higher concentration of linoleic acids. Sunflower seed comprises 20-27% protein and 40-47% oil. It is an excellent source of crude protein, fibers, unsaturated fats and key nutrients including vitamins (E, B-complex) and minerals (zinc, copper and selenium) (Gonzalez et al., 2002).

Among non-traditional oilseed crops, sunflower has greater potential for narrowing up the gap between the supply and demand of edible oil. But sunflower yield in Pakistan is far lower than the genetic potential yield of crop due to different factors, such as nutrient imbalance, less irrigation, less plant population and low soil fertility. Among these factors, imbalanced nutrition is one of the major causes of low yield of sunflower in the country. Due to cultivation of high yielding varieties, intensive agriculture, low use of organic matters and increased use of micronutrients free fertilizers, Pakistani soil has become deficient in micronutrients. Exhaustive crops cultivation and improper usage of fertilizers have resulted in deficiency of nutrients in fields. For such exhaustive cropping systems, the optional dose of nutrients needs to be updated with equilibrium of important trace nutrients, particularly to increase our standing yield (Tandon, 1997). Fertilization is an important practice for the application of some micro nutrients because it uses low rates and the micro nutrients do not come into contact with the soil, which avoid their losses through fixation. Among all nutrients which required by plants, nitrogen is vital for photosynthesis and plant dry matter. It had been reported for significant role in crop yield and quality (Wang et al., 2002).

The importance of micronutrients can be assumed if anyone could ever know that these help in activation of hundreds of enzymes which take part in different catabolic and anabolic processes. These play a key role in the regulation of CO_2 and enhancing activity of immune system (Marschner, 1995). Micronutrients deficiency can greatly disturb crop production which ultimately affects human health (Malakouti, 2008). In addition to enhancing seed production, micronutrients help plant to take up macronutrients (Phillips, 2004). Micronutrient's foliar spray may induce resistance against diseases as in case of cucumber when a single spray of H_3BO_3, In addition to enhancing seed production, micronutrients help plant to take up macronutrients (Phillips, 2004).

Among others, nutrients management through foliar application is considered as most important way of providing what plant needs most. Foliar application of fertilizer means the exercise of applying fluid fertilizers to plant foliage. To reduce stress and to cope with nutrient deficiency, specifically, micronutrient deficiency, foliar of micro nutrients is considered as most effective and most efficient method.

Plants require 16 elements for their growth and development which have been classified as macro and micronutrients. Micronutrients play a very important role in the growth, yield and quality of crops. Boron application increases the achene oil quality and its uptake by plants in seeds has increasing response on the quality of oil (Survas et al., 1986). Among the micronutrients $ZnSO_4$ and $MnSO_4$ play an important function for plants growth and development (Alloway, 1990). Micronutrients applied in combination with Rhizobium increased growth and yield of mung bean (Ahmad et al., 2013) A large scope exists to examine the use of various arrangements of macro and micro nutrients on different crops as they are inexpensive, required in lesser amount, potentially non harmful, environment friendly and feasible under soil and plant system. Keeping in view the significance of crop nutrients for enhancing the production of crops, this study was conducted to investigate the influence of combined use of nutrients on quality and yield of sunflower to evaluate the response of sunflower against multi nutrients applied at different growth stages and to examine the mutual effect of micro and macro nutrients on the productivity of sunflower when applied at different growth stages.

MATERIALS AND METHODS

The study was conducted during autumn at Agronomic Research Area, University of Agriculture, Faisalabad, Pakistan (31°21'52"N, 72°59'40"E). The trial was conducted in Randomized Complete Block Design having a net plot size of 4.5 m × 7 m using three replications. Treatments were T_1=control; T_2= recommended dose of fertilizer (RDF); T_3=single spray of multi nutrients at V_4 stage (four leaves stage); T_4=RDF+ 1 spray of multi nutrients at V_4 stage; T_5=2 spray of multi nutrients at V_4 and V_8 stages; T_6=RDF+ 2 spray of multi nutrients at V_4 and V_8 stages; T_7= three spray of multi nutrients at V_4, V_8 and V_{12} stages; T_8=RDF+ 3 spray of multi nutrients at V_4, V_8 and V_{12} stages. Multinutrients including Zn (4.7%), Mn (2%), Fe (2%), B (1%) and Cu (0.3%) were applied at the rate of 1.25 L/ha. Seed was treated with fungicide before sowing. Nitrogen was used in three splits i.e. half at sowing time, 1/4th at 1st irrigation and remaining 1/4th at flowering. Phosphorus and potassium were used at the time sowing. The collected data was examined statistically using Fisher's analysis of variance technique and treatments' means were compared by least significant difference (LSD) test at 5% probability level (Steel et al., 1997).

RESULTS AND DISCUSSION

Application of multinutrients showed a non-significant effect on the number of plants per plot at harvest. However, the mean values for the number of plants per plot differed from 50 to 51.33 which proved non-significant effect of multi nutrients. It might be due to the thinning practice which was completed at four leave stage to obtain uniform plant population. While, significantly higher plant height of sunflower (130.01 cm) was recorded in the treatment (T_4) where recommended dose of fertilizer (RDF) + single spray of multi nutrients (1.25L/ha at V_4) were applied. On the other hand, the lowest plant height (120.52 cm) was recorded in the treatment (T_1) in which no fertilizer and multi nutrients were applied (control) (Table 1). Negm and Zahran, (2001) also confirmed the same trend in wheat crop. Stem is the vital part of any plant. Development of plant and its health depends upon the growth of its stem as it plays key role in the transportation of water and other essential nutrients from roots to the upper portion of the plant. The mean values for stem diameter showed significant differences among treatments means. The significantly higher stem girth of sunflower plant (3.08 cm) was observed in the treatment (T_8) where RDF +3 sprays of multi nutrients (1.25L/ha at V_4, 1.25L/ha at V_8 and 1.25L/ha at V_{12} stages) were applied. The lowest value of stem diameter (1.72 cm) was recorded in the treatment (T_1) in which no fertilizer and multinutrients were applied (control). These consequences were alike with outcomes of the El-Floudy et al. (2001) who reported that sunflower significantly responds to boron and zinc application which increases the stem diameter of sunflower plant.

The maximum head diameter was 14.92 cm of sunflower plant in the treatment T_8 where RDF + 3 sprays of multi nutrients (1.25L/ha at V_4, 1.25L/ha at V_8 and 1.25L/ha at V_{12} stages) were applied while the minimum head diameter was 13.64 cm in the treatment T_1 in which no fertilizer and no multinutrients were applied. Cakmak et al. (2010) also reported that head diameter significantly increased in result of foliar application of Zn along with soil application of phosphorus in sunflower. Head diameter might be increased due to the balanced amount of nutrients which had significant effect on metabolic and physiological process which played important role of catalyst in cell elongation, formation and carrying of sugars and synthesis of protein. Iron plays important role in respiration of plants as well as in photosynthesis and chlorophyll formation (Havlin et al., 1999). Number of achene per head were 1175.00 of sunflower in the treatment (T_8) where RDF +3 sprays of multi nutrients (1.25L/ha at V_4, 1.25L/ha at V_8 and 1.25L/ha at V_{12} stages) were applied. Micronutrients (B+Mn) had significant effects on number of achene per head of sunflower when applied as a foliar spray (Jabeen and Ahmad, 2012). The significantly maximum 1000 achene weight was 52.45 g of sunflower in the treatment (T_8) where RDF +3 sprays of multi nutrients (1.25L/ha at V_4, 1.25L/ha at V_8 and 1.25L/ha at V_{12} stages) were applied. Application of RDF+3 sprays of multi nutrients (1.25 L/ha at V_4, 1.25 L/ha at V_8 and 1.25 L/ha at V_{12} stages) enhanced 1000-achene weight and it might be due to the reduction in the bad effects of any type of stress and provide the balance nutrients and play key role in metabolism of carbohydrate and development of seed in sunflower (Cakmak and Romheld, 1997).

Sunflower achene yield was affected by various yield contributing attributes such as genetic makeup of hybrid, various agronomic practices that were adopted in field and the set of specific environmental conditions at micro and macro level. Maximum achene yield was 2900 kg/ha of sunflower in the treatment (T_8) where RDF+3 sprays of multi nutrients (1.25L/ha at V_4, 1.25L/ha at V_8 and 1.25L/ha at V_{12} stages) were applied while significantly the minimum achene yield was 1332.4 kg ha^{-1} in the treatment (T_1) in which no fertilizer and no multi nutrients were applied. Khurana and Chatterjee (2001) stated that the achene yield of sunflower improved with the foliar use of micro

Table 1: Effect of Integrated Nutrients Use on yield and quality parameters of Sunflower

Sr. no	No. of plants per plot	Plant height (cm)	Head Diameter (cm)	Stem Dia meter (cm)	Number of achene per head	1000 grain weight (g)	achene yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest index (%)	Achene oil content (%)	Achene protein content (%)
T_1	50.66NS	120.52^{c}	13.64^{g}	1.72^{c}	700.30^{e}	39.44^{f}	1332.4^{f}	12278^{b}	10.80^{f}	40.70^{d}	22.00^{d}
T_2	51.33	124.66^{b}	14.32^{c}	1.84^{c}	930.70^{c}	48.98^{c}	2200.0^{c}	13611^{a}	16.14^{c}	42.10^{bc}	23.00^{bc}
T_3	51	121.05^{c}	13.70^{fg}	2.04^{bc}	738.80^{de}	39.44^{f}	1450.0^{e}	12278^{b}	11.80^{ef}	41.10^{d}	22.10^{d}
T_4	51	130.01^{a}	14.25^{cd}	1.81^{c}	1065.90^{b}	49.54^{bc}	2650.2^{b}	13889^{a}	19.08^{b}	42.90^{b}	23.02^{bc}
T_5	50	120.53^{c}	14.06^{de}	2.17^{bc}	790.80^{de}	41.22^{e}	1600.0^{d}	12333^{b}	12.96^{d}	41.10^{d}	22.70^{c}
T_6	50	128.75^{a}	14.56^{b}	2.52^{ab}	1155.70^{ab}	50.24^{b}	2800.0^{a}	13944^{a}	20.08^{ab}	43.30^{a}	23.40^{ab}
T_7	50.33	123.26^{b}	13.88^{ef}	2.24^{bc}	770.50^{d}	43.24^{d}	1650.5^{d}	12722^{b}	12.65^{de}	41.50^{cd}	23.00^{bc}
T_8	50.66	129.28^{a}	14.92^{a}	3.08^{a}	1175.00^{a}	52.45^{a}	2900.0^{a}	13978^{a}	20.77^{a}	43.45^{a}	23.80^{a}
LSD (5%)	NS	2.01	0.22	0.57	90.19	0.76	105.73	567.55	1.14	0.93	0.56

Any two means not sharing same letter differ significantly at 5% level of probability.

nutrients. Significantly the maximum harvest index was 20.77% of sunflower in the treatment (T_8) where RDF+3 sprays of multi nutrients (1.25L/ha at V_4, 1.25L/ha at V_8 and 1.25L/ha at V_{12} stages) were applied. Similarly, Rana et al. (2005) described that harvest index increased when micro nutrients like sulfur and boron were applied on Indian mustard. Dietary value and quality of sunflower achene may be indicated by the presence of protein content. Now a day's all the nations are concentrating the balance in diet which can be obtained by producing quality oil and protein. Crop rich in oil content is the ultimate goal of growers. High oil content has the dynamic importance in quality of sunflower. Achene oil content and protein content were maximum in treatment having optional dose of fertilizer along with three sprays of multi nutrients T_8.

Conclusion

From the present study it can be suggested that N P K at the ratio of 110,57,62 kg ha^{-1} + three sprays of multi nutrients (Zn 4.7%, Mn 2%, Fe 2%, B 1% and Cu 0.3%) applied at the rate of 1.25 L/ha at V_4 (four true leaves), V_8 (Eight true leaves) and V_{12} (twelve true leaves) stages of sunflower (hysun 33) could be helpful for the enhancement of the yield under climatic conditions of Faisalabad, Pakistan.

Authors' contributions

All authors contributed equally in experimental work and writing this manuscript.

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