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Effect of growth regulators on yield and yield contributing characters of sunflower (*Helianthus annuus* L.) variety Phule Bhaskar during *kharif* season

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Abstract
A field experiment was conducted during *Kharif*, 2017 at Post Graduate Institute Farm, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar to study the "Effect of growth regulators on yield and yield contributing characters in sunflower variety Phule Bhaskar during *kharif* season".
The experiment was laid out in a randomised block design (RBD) with three replications and eight treatments involving variety Phule Bhaskar and the plant growth regulators *viz.*, T_1 [Control], T_2 [GA_3 (250 ppm)], T_3 [TIBA (240 ppm)], T_4 [NAA (50 ppm)], T_5 [Kinetin (200 ppm)], T_6 [BA (250 ppm)], T_7 [Boron (0.2%)], T_8 [Hand Pollination].
The present study was undertaken to find out an appropriate growth regulator for seed filling in sunflower (*Helianthus annuus* L.). The foliar sprays of PGR's were given at the time of 50% flowering and seed formation.
In case of yield and yield contributing characters *viz.*, weight of seeds per head, total dry weight of the plant, yield q/ha, harvest index and oil content; among all the treatments, Treatment T_7 (0.2% boron) resulted best performance which was significantly superior over control. The Treatment T_3 (TIBA 240 ppm) recorded highest 100 seed weight (8.69 g) followed by treatment T_7 (0.2% boron) (8.40 g) showed best performance.

Keywords: sunflower, growth regulator, yield, boron, PGRs, TIBA, kinetin

Introduction
Sunflower (*Helianthus annuus* L.) is the most important oilseed crops of the world because of the unsaturated fatty acids (900g kg^{-1}) in its oil has gained popularity among all the oilseed crops. The excellent quality of sunflower oil is due to its richness with high degree polyunsaturated fatty acids, anti-cholesterol properties, short duration, wide adaptability to soil and climatic conditions, photo and thermo-insensitiveness, drought tolerance and higher oil yield per unit area. In India, it is cultivated over an area of about 2.4 million hectares with the production of 1.44 million tonnes with productivity of 6.08 q ha^{-1} as against 12.71 q ha^{-1} of the world productivity (Rasool *et al*., 2013) [3].
Sunflower is an important oilseed crop with almost 20-27% protein and 40-47% oil content. It is a wealthy source of vitamins A and D. Its oil is called premium oil due to the presence of oleic acid (16.2%) and linoleic acid (72.5%) with high percentage (60%) polyunsaturated fatty acid. The seed cake of sunflower used for cattle feed which is a good source of protein (Tahir *et al.*, 2014) [4].
Seed setting and filling is one of the most important constraints in sunflower production and often considered to be a major reason for low productivity. Besides poor agronomic management, there are several genetic, physiological and environmental factors causing poor seed setting and filling in sunflower. The sporophytic type of self-incompatibility mechanism is one of the genetic reasons for poor seed setting in sunflower. The physiological mechanisms that regulate seed setting and filling in sunflower are complex (Ram and Davari, 2011) [2].
Plant growth regulators (PGRs) have the capacity to modify every phase of plant growth spanning from seed germination to crop maturity. Since most plant growth and seed development processes are regulated by natural plant hormones, many of these processes might be manipulated either by altering the endogenous hormone level or by changing the

capacity of the plant to respond to its natural hormones. It is well known that plant hormones are involved in grain filling and seed development (Al- Jobori, 2012) [1].

The present investigation entitled “Effect of growth regulators on seed filling of sunflower during *kharif* season” is undertaken to know the response of sunflower to application of growth regulators viz., GA_3, TIBA, NAA, Kinetin, BA, Boron and hand pollination in relation to yield and yield contributing attributes.

Materials and Methods

A field experiment on sunflower was conducted at Post Graduate Institute Farm, Department of Agricultural Botany, Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar. The present investigation was undertaken during the *Kharif* season. The experiment was laid out in randomized block design with three replications. The variety of sunflower was Phule Bhaskar. Recommended dose of 40:30:30 kg N, P_2O_5, K_2O ha^{-1} in the form of Urea, DAP and muriate of potash was applied to the soil as basal dose. The seeds were sown on 14th July, 2017 at spacing of 60×30 cm. The irrigation was given at whenever necessary. The recommended cultural operations and plant protection measures were carried out timely. The foliar sprays of PGR’s were given at the time of 50% flowering and seed formation.

Results and Discussion

1. 100 seed weight (g)

The significantly highest 100 seed weight (8.69 g) was recorded in Treatment T_3 (TIBA 240 ppm), which was significantly superior over rest of the treatments. It was noteworthy to point that application of TIBA to head has resulted in increased filling and test weight by way of increased translocation of photosynthates to sink.

2. Weight of seeds/head (g)

The significantly highest seed weight (79.64 g) was recorded in Treatment T_7 (0.2% boron) which was significantly superior over rest of the treatments.

3. Total dry weight of the plant (g)

The dry matter production is the result of cumulative and complementary effect of plant height, number of leaves, leaf area and root weight. Dry matter production differed significantly due to application of boron. The significantly highest dry weight of the plant (176 g) was observed in Treatment T_7 (0.2% boron) and the lowest (163.02 g) in Treatment T_1 (control). The higher dry matter production in these treatments might be due to the boron role in increasing photosynthetic activity, which resulted in increase in plant height, number of leaves, leaf area and root growth.

4. Yield q/ha

The Treatment T_7 (0.2% boron) recorded significantly highest yield (23.84 q/ha) over rest of the treatments. However, significantly lowest seed yield (17.18 q/ha) was observed in Treatment T_1 (control). Sufficient source, a strong sink and better translocation between these two are essential for higher seed setting and yield of sunflower. The process of seed setting occurs in a short period after pollination and fertilization.

5. Harvest index (%)

Significantly highest harvest index was recorded (45.26%) in Treatment T_7 (0.2% boron) which was significantly superior over rest of the treatments. Harvest index is a measure of determining productivity of a crop.

6. Oil content (%)

The data revealed that the significantly highest oil content (38.87%) was recorded in Treatment T_7 (0.2% boron) which was significantly superior over rest of the treatments, however the lowest oil content (36.50%) was recorded in Treatment T_1 (control). This might be due to after pollination and seed set, the formation of protein start and there after oil synthesis start.

Table 1: 100 seed weight, weight of Seeds/head, total dry weight of the plant, yield q/ha, harvest index and oil content of sunflower variety Phule Bhaskar as influenced by PGRs (Plant Growth Regulators)

S. No.	Treatments	100 seed weight (g)	Weight of seeds/head) (g)	Total dry weight of plant (g)	Yield q/ha	Harvest Index (%)	Oil content (%)
T_1	Control	6.95	68.00	163.02	17.18	41.73	36.50
T_2	GA_3 (250 ppm)	7.73	70.50	164.10	19.32	42.98	37.42
T_3	TIBA (240 ppm)	8.69	74.96	169.80	22.10	44.15	38.71
T_4	NAA (50 ppm)	7.74	74.04	168.55	21.00	43.93	38.10
T_5	Kinetin (200 ppm)	7.96	77.82	173.65	23.15	44.84	38.60
T_6	BA (250 ppm)	8.39	73.07	167.35	20.54	43.67	37.80
T_7	Boron (0.2%)	8.40	79.64	176.00	23.84	45.26	38.87
T_8	Hand Pollination	8.27	76.96	170.42	19.73	45.16	37.51
	SE(±)	0.06	0.87	2.00	0.33	0.71	0.17
	CD @5%	0.19	2.63	6.07	1.00	2.15	0.51

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