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Morpho-Chemical and Physiological Response of Sunflower (*Helianthus annuus* L.) to Gibberellic Acid and Nitrogen.

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Abstract

An experiment was conducted to evaluate the effect of Gibberellic Acid (GA_3) on yield and quality of two sunflower cultivars i.e. Hysun 33 and LG 5680, grown in normal and nitrogen fertilized soil. Three concentrations of GA_3 i.e. 10, 20 and 30 mg L^{-1} were sprayed 30 days after germination. Increasing concentrations of GA_3 gradually improved oil and carbohydrate contents. Yield parameters i.e. achene yield, 1000-achene weight, capitulum diameter and dry biomass also, gradually increased as the concentration of GA_3 increased. Nitrogen application further improved the biochemical and yield parameters. Sunflower cultivar LG 5680 surpassed Hysun 33 in terms of higher oil, carbohydrate, capitulum diameter, etc.

Keywords: Sunflower, physiological response, gibberellic acid, nitrogen

Introduction

The total edible oil production in Pakistan is much less than the national demand. The main reasons attributed to wide yield gap include imbalanced use of fertilizers, poor quality seed, insect pest attack, weed infestation and hostile environmental conditions. Hence, for an improvement in the productivity potential of oilseed crops exploitation of high yielding crop cultivars and modern agronomic practices seems very imperative.

Sunflower oil being free from toxic substances and having high percentage of linolinic acid, as well as, vitamins A, D, E and K, is considered better in quality than other edible oils. Its dehulled seeds contain 45% oil content, 40% protein, 25-36% carbohydrates especially lipids containing very small concentration of phospholipid (2%) and glycolipid (<1%) (Vaughan, 1970).

The environmental conditions in Pakistan are very conducive for sunflower (*Helianthus annuus L.*). cultivation. It is being cultivated over 11761 hectares (Govt of Pakistan, 2000) which cannot be further extended due to interest of farmers in other cash crops. However its productivity potential can be further enhanced by using growth promoting substances, good quality seeds and appropriate use of fertilizers.

Among the naturally occurring growth hormones, Gibberellic acid (GA_3) is considered of specific importance in promoting the plant growth. Exogenous application of GA_3 not only increases the vegetative growth, but also, promotes crop yield, 1000 seed weight and seed number/capitulum (Shunkla *et al.*, 1987 and Madrap *et al.*, 1992).

Nitrogen being a major plant nutrient and an essential constituent of proteins has great bearing in regulating the various physiological and metabolic processes in plants. Its deficiency, however reduces the chlorophyll production and drastically affects crop growth. Nevertheless, the availability of nitrogen not only improves the vegetative and reproductive growth of sunflower, but also, positively influences the oil content (Bindra and Kharwara, 1992, Jaybhaye *et al.*, 1992).

A combined use of GA_3 and nitrogen also results in a positive interaction between growth regulator and nitrogen and synergistically causes further improvement in oil and protein content and in crop yield (Al-Gharbi and Yousif, 1989, Anton *et al.*, 1995). The objectives of this study was to evaluate the combined effect of GA_3 and nitrogen on the yield and quality of two sunflower cultivars, i.e. LG 5680 and Hysun 33.

Materials and Methods

An experiment was conducted in earthen pots lined with polyethylene bags containing 9 Kg sun dried soil to study the effect of three concentrations of Gibberellic acid (10, 20 and 30 mg L^{-1}) with nitrogen (@ 60 Kg N ha^{-1}) i. e. N_1G_0, N_1G_1, N_1G_2,N_1G_3 and without nitrogen i. e. N_0G_0, N_0G_1, N_0G_2, N_0G_3 applied 30 days after germination on two sunflower (*Heliantus annuus*.L) cultivars; LG-5680 (V_1) and Hysun-33 (V_2). The experiment was laid out in a Completely Randomized Design (CRD) with three factor factorial arrangement having three replications and eight treatments for each varity.

Data for plant biomass, achene yield and 1000 achene weight were collected. Achenes were analyzed for oil and carbohydrate contents. The data collected were analyzed statistically (Steel and Torrie (1980). The

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treatment means were compared using Duncan's New Multiple Range Test (DMRT)

Results and Discussion

The data for the effect of gibberellic acid (GA_3) and nitrogen on the plant biomass, capitulum diameter, 1000-achene weight, achene yield/plant, oil content and carbohydrate content of two sunflower cultivars have been presented in Table 1.

Data indicate that different gibberellic acid treatments significantly influenced plant biomass of both sunflower cultivars i.e. LG 5680 (V_1) and Hysun 33 (V_2). The increasing concentrations of gibberellic acid (GA_3) with or without nitrogen gradually increased plant biomass. The maximum and statistically similar plant biomass of 3.20 g and 2.93 g respectively was recorded for N_1G_3 in both the varieties. The minimum plant biomass of 2.71 g and 2.63 g differing significantly from the control was recorded for gibberic acid treated plants (N_0G_1) for both varieties. The intermediate level of gibberellic acid treatment also possessed significantly higher plant biomass than that recorded for control. All the GA_3 treatments with or without nitrogen in V_1 (LG 5680) surpassed V_2 (Hysun 33). From these results it can be concluded that gibberellic acid might have enhanced cell size and improved vegetative growth to increase plant biomass. These results are in accordance with the findings of Khan (1996).

The 1000-achene weight also, got gradually improved in response to increasing levels of GA_3. The differences among the treatments were statistically significant. They showed an increase of 12.97% (N_1G_1) to 91.06% (N_1G_3) in V_1 (LG 5680) and 16.66% to 96.12% in V_2 respectively. This gradual increase in 1000-achene weight with the increasing concentrations of GA_3 was recorded for all the GA_3 treatments with or without nitrogen V_1 (LG 5680) surpassed V_2 (Hysun 33) in respect of 1000-achene weight. Madrap (1992) treated safflower cultivar S-4 with three concentrations (50, 100 and 200 ppm) of GA_3 and reached almost the same conclusion for achieving the highest 1000 achene weight for 50 ppm treated plants.

The achene yield/plant was significantly influenced by the gibberellic acid and nitrogen treatments in both sunflower cultivars. The maximum achene yield/plant was recorded for (N_1G_3) for all the plants which received nitrogen treatment; it was followed by (N_1G_2) and (N_1G_1) in both sunflower cultivars. The differences among the GA_3 treatments were significant. Treatments receiving nitrogen application also showed a resembling trend in both sunflower cultivars for possessing maximum achene yield(2.52 g) in(N_1G_3) for V_1 (LG_1 5680). The same pattern was recorded for V_2 (Hysun 33).

The availability of excessive nitrogen and GA_3 might have improved the vegetative as well as reproductive growth. These results resemble the findings of Anton *et al.* (1995) who concluded that gibberellic acid and nitrogen showed positive interaction for seed yield.

In both sunflower cultivars the oil content of seed was not significantly influenced by the GA_3 and nitrogen application. Plants treated with gibberellic acid along with nitrogen (N_1G_1), (N_1G_2), (N_1G_3) application showed 21.10%, 24.37% and 28.98% respectively increase in oil content. Gibberellic acid treatment without nitrogen application also, showed 15.53%, 18.0% and 23.60% improvement in oil content in ($N_0G_$), (N_0G_1), (N_0G_2) and (N_0G_3) respectively in V_1 (LG 5680) sunflower cultivar. A similar trend was recorded regarding the influence of gibberellic acid treatments and nitrogen application in V_2 (Hysun 33) cultivar. Similar enhancement in oil content by GA_3 application has been reported in sunflower (Hiremath *et al.,*1992; Kene *et al., 1*995) and safflower (Nimje and Gandi, 1993; Kene *et al., 1995*).

Table 1: Morpho-chemical and physiological response of sunflower (*Helianthus annuus* L.) to Nitrogen under different concentrations of Gibberellic Acid (GA_3)

Parameters	Varieties	Without nitrogen (N_0)				With nitrogen (N_1)			
		G_0	G_1	G_2	G_3	G_0	G_1	G_2	G_3
Plant biomass (g)	V_1	2.48f	2.71e	2.77d	2.88c	2.70e	2.86c	3.08b	3.20a
	V_2	2.67f	2.67e	2.67e	2.77c	2.63e	2.72d	2.85b	2.93a
1000-achene weight(g)	V_1	16.11g	18.20f	25.60c	26.02c	20.87e	23.01d	28.41b	30.78a
	V_2	15.24f	17.78e	24.41c	24.82c	19.48e	22.18d	27.66b	29.89a
Achene yield/plant (g)	V_1	1.71f	1.91d	1.99d	2.09c	1.94d	2.12c	2.23b	2.52a
	V_2	1.71f	1.97d	2.12c	2.36b	1.95d	2.15c	2.45b	3.22a
Oil content (%age)	V_1	36.31	41.95	42.85	44.88	41.73	43.97	45.16	46.8
	V_2	38.05	40.3	40.95	43.97	40.86	42.76	43.45	46.06
Carbohydrate (%age)	V_1	0.43	0.49	0.53	0.71	0.54	0.66	0.82	0.99
	V_2	0.39	0.43	0.46	0.67	0.47	0.51	0.72	0.77

N_0 = Without nitrogen; N_1 = Nitrogen @ 60kg $ha^{-1;}$ G_0 = Without GA_3; G_1 = 10 mg $L^{-1}GA_3$; G_2 = 20 mg L^{-1} GA_3; G_3 =30 mg L^{-l} GA_3 ; V_1 = LG-5680; V_2 = Hysun-33.

The carbohydrate content of both sunflower cultivars for the different gibberellic acid treatment either treated with nitrogen or not differ non-significantly. However, in V_1 (LG 5680), the carbohydrate content for all the gibberellic acid treatments was found slightly greater than that recorded for V_2 (Hysun 33). Similar results have been reported by Guweihang (1998) for examining improvement in the carbohydrate content of soyabean when treated with GA_3 alongwith foliar fertilization.

From these results, it can be concluded that combined application of gibberellic acid and nitrogen fertilizer has great potential for improving the quality and quantity of sunflower production.

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