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Study on the effect of gibberellic acid and maleic hydrazide on growth and yield attributing characters of okra (*Abelmoschus esculentus* (L.) Moench) cv. Varsha Uphar

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Abstract
A field experiment was conducted at Horticulture Research Farm, Department of Horticulture, RAK College of Agriculture Sehore during Kharif season of 2012-13. The experiment was laid out in Randomized Complete Block Design with three replications. Combination of gibberellic acid and maleic hydrazide, treatment T_9 (100 ppm MH + 60 ppm GA_3) was found significantly superior as compared to other treatments. Highest morphological characters (viz., plant height, number of leaves per plant, number of branches per plant, stem girth per plant and leaf area index) and yield attributes (viz., no of fruits per plant, fruit yield/plant and fruit yield /ha) were recorded in T_9 (100 ppm MH + 60 ppm GA_3). Maximum fruit yield of 125.29 q/ha obtained in treatment T_9 but maximum net return of Rs 88698 /ha and cost benefit ratio of 1:3.52 was observed in treatment T_8 (100ppm MH+ 40 ppm GA_3).

Keywords: Gibberellic acid, maleic hydrazide, yield attributing, *Abelmoschus esculentus* (L.) Moench

Introduction
Okra (*Abelmoschus esculentus* (L.) Moench, 2n=130) is considered to be one of the most important vegetables in India and many countries, especially during summer season. India is a largest producer (72.9%) of okra (Bhindi) in the world (Anonymous, 2014) [1]. Okra is belonging to the family Malvaceae and a self pollinated crop, occurrence of out crossing to an extent of 0.34-27.30% is noticed with the insect assisted pollination (Kalloo, 1994) [6]. Okra is an annual fruit vegetable crop grown in tropical and subtropical parts of the world. Although okra is primarily a rainfed crop, it also comes up well under irrigated condition during kharif and summer season. It is grown for tender fruits, which are used for cooking. All over India, its immature tender fruits which are botanically called capsules are used as vegetable. Also these tender fruits can be dehydrated and marketed for vegetable purpose. Its leaves are used for preparing a medicament to reduce inflammation. It is an excellent source of Iodine for control goiter (Chadha, 2001) [2]. The roots and stems of okra are used for clearing the sugar cane juice while preparing jaggery and sugar.

Growth and yield of okra depends upon many factors including seed quality, nutrition, climatic conditions and cultural practices (Kusvuran, 2012) [8]. The application of plant growth regulators is known as one of the most effective treatments used now a days in agriculture, productivity of horticulture crop productions were increased by application of different growth regulators (Jafarullah *et al*., 2007) [5]. Chemical substances like plant growth regulators can bring changes in the phenotypes of plants and affect growth either by enhancing or by stimulating the natural growth regulatory systems from seed germination to senescence (Das and Das, 1995) [3]. These can improve physiological efficiency of plants including photosynthetic capacity and effective partitioning of assimilates. Regulators mainly regulate the plant physiological and biochemical processes. PGRs are known as chemical messengers because they are produced in one part of plant and affect on another part. Exogenous application of plant growth regulators improved the yield production and fruit quality of horticulture crops. The plant growth regulators have multifarious uses on fruit vegetable *i.e*, seed germination, sex modification, fruit set, size manipulation of fruits, earliness of crop and enhanced production. Some of them are naturally occurring, organic substances that affect the plant growth when used at low concentrations and sometimes they act as inhibitors at high concentrations. Gibberellins, which is natural plant hormone. GA_3 has many effects on plant growth such as enhance stem and internodes elongation, produce seed germination, enzyme production during germination and fruit setting and growth (Davies *et al*., 1995; Karssen *et al*., 1989) [4, 7]. Maleic hydrazide is a plant growth regulator (sprout inhibitor) and herbicide, that acts by inhibiting cell division in plants.

It is used to control sprouting of potatoes and onions, suckers in tobacco. Hence the present investigation was undertaken to study the effect of gibberellic acid and maleic hydrazide on growth and yield of okra (*Abelmoschus esculentus* (L.) Moench) cv. Varsha Uphar.

Materials and Methods

A field study was undertaken during kharif season of 2012-13 at Horticulture Research Farm, Department of Horticulture, R.A.K. College of Agriculture, Sehore (M.P.). The experimental site situated on 27º12 North latitude and 77º0 East longitude at an altitude of 498.77 meters from mean sea level in Vindhyan Plateau of Madhya Pradesh. The soil of the experimental field was medium black. There were ten treatments combination. The treatments comprises of three level of MH (M_1-60 ppm, M_2-80 ppm, M_3-100 ppm) and three levels of GA_3 (G_1-20 ppm, G_2-40 ppm, G_3-60 ppm). The experiment was laid out in Randomized Block Design with three replication. Various concentration of Maleic hydrazide and Gibberellic acid was sprayed in respective plot at 15, 30 and 45 DAS with tipole as sticker. Five tagged plant from each plot were selected for recording observation of growth and yield parameters.

Result and Discussion

It was observed from Table -1 that plant height, number of leaves per plant and stem girth per plant was significantly increased by various treatments of gibberellic acid and maleic hydrazide. Treatment T_9 M_3G_3 (100 ppm MH + 60 ppm GA_3) was found significantly superior as compared to T_8 M_3G_2 (100 ppm MH + 40ppm GA_3). However it was observed lowest under the treatment T_{10} (Control). These findings are also consonance with Naruka and Paliwal (2000) [9], Singh and Kumar (2005) [12].

At 30 DAS the plant of okra was mono-stem it indicates no branches were exhibited in any treatments. At 45 DAS the number of branches was significantly influenced by different treatments of gibberellic acid and maleic hydrazide. Treatment T_9 M_3G_3 (100 ppm MH + 60 ppm GA_3) was found significantly superior as compared to T_8 M_3G_2 (100 ppm MH + 40 ppm GA_3).

The treatment T_9 M_3G_3 (100 ppm MH + 60 ppm GA_3) was found significantly superior to leaf area index. These findings are in agreement with the findings of Nagita *et al*. (2004) [10].

The days to first flowering, days to 50% flowering and days to first picking was recorded under treatment T_9 M_3G_3 (100 ppm MH + 60 ppm GA_3). It is concluded that all the growth regulators treatment found beneficial in first flowering, days to 50% flowering and days to first picking over control. The significantly maximum (93.33 days) for maturity was recorded in treatment T_9 M_3G_3 (100 ppm MH + 60 ppm GA_3). However, the treatment T_{10} (Control) was recorded lowest (89.00 days) to maturity as compared to other treatments. From the Table-2, the maximum fruit per plant, fruit length, fruit girth and fruit weight were exhibited under the treatment T_9 M_3G_3 (100 ppm MH + 60 ppm GA_3). While lowest fruit per plant, fruit length, fruit girth and fruit weight were noted in treatment T_{10} (Control). The reason for maximum fruit per plant, fruit length, fruit girth and fruit weight may be due to better translocation of photosynthates. These findings are in agreement with the findings of Singh *et al*. (2004) [11] reported that the gibberellic acid upto 150 ppm increased the length of fruit, diameter of fruit, mean fruit weight, number of pickings and duration of harvesting.

It is revealed from data obtained that a significantly maximum fruit yield of 125.29 q/ha, net return of Rs 88488/ha and cost benefit ratio of 1:3.40 was obtained in okra variety Varsha Uphar in treatment T_9 M_3G_3 (100 ppm MH + 60 ppm GA_3). But maximum net return of Rs 88698 /ha and cost benefit ratio of 1:3.52 was observed in treatment T_8 M_3G_2 (100 ppm MH + 40 ppm GA_3).

Table 1: Effect of gibberellic acid and maleic hydrazide on growth parameters of Okra.

Treatment Symbol	Treatments	Plant Height at 30 DAS	No of leaves/plant at 30 DAS	No of branches /plant at 45 DAS	Stem girth /plant at 30 DAS	Leaf Area Index at 30DAS	Days to first flowering	Days to 50% flowering	Days to first picking	Days to maturity
T_1	M_1G_1 (60 ppm MH+ 20ppm GA_3)	25.50	6.51	1.00	1.90	0.160	38.00	43.66	48.00	89.66
T_2	M_1G_2 (60 ppm MH+ 40ppm GA_3)	26.36	6.63	1.26	2.12	0.161	37.33	43.33	47.66	90.00
T_3	M_1G_3 (60 ppm MH+ 60ppm GA_3)	29.13	6.90	1.80	2.27	0.164	37.00	43.00	47.33	91.00
T_4	M_2G_1 (80 ppm MH+ 20ppm GA_3)	30.10	7.13	2.06	2.34	0.187	36.66	42.66	47.00	91.33
T_5	M_2G_2 (80 ppm MH+ 40ppm GA_3)	30.93	7.21	2.20	2.41	0.188	36.33	42.33	46.66	91.66
T_6	M_2G_3 (80 ppm MH+ 60ppm GA_3)	31.00	7.53	2.40	2.53	0.208	36.00	42.00	46.33	91.66
T_7	M_3G_1 (100 ppm MH+ 20ppm GA_3)	31.03	7.88	2.60	2.68	0.208	35.66	41.00	46.00	92.00
T_8	M_3G_2 (100 ppm MH+ 40ppm GA_3)	31.76	8.06	2.76	2.88	0.209	35.33	40.33	45.66	93.00
T_9	M_3G_3 (100 ppm MH+ 60ppm GA_3)	33.83	8.40	2.93	2.96	0.238	35.00	40.00	45.00	93.33
T_{10}	Control	19.53	5.43	0.46	1.63	0.154	38.66	46.00	50.33	89.00
SEm+-		0.61	0.15	0.27	0.02	0.005	0.44	0.68	0.54	0.45
CD at 5% level		1.83	0.47	0.83	0.06	0.014	1.32	2.04	1.64	1.36

Table 2: Effect of gibberellic acid and maleic hydrazide on yield and yield parameters of Okra.

Treatment Symbol	Treatments	No of fruits/plant	Fruit length (cm)	Fruit girth (cm)	Fruit weight (gm)	Fruit yield q/ha	Net income (Rs/ha)	C:B ratio
T_1	M_1G_1 (60 ppm MH+ 20ppm GA_3)	13.93	10.87	14.74	8.02	84.86	51398	1:2.53
T_2	M_1G_2 (60 ppm MH+ 40ppm GA_3)	15.26	10.95	14.86	8.44	89.49	54378	1:2.55
T_3	M_1G_3 (60 ppm MH+ 60ppm GA_3)	16.90	11.01	15.01	8.62	90.42	53658	1:2.46
T_4	M_2G_1 (80 ppm MH+ 20ppm GA_3)	17.26	11.20	15.36	9.06	100.34	66858	1:3.00
T_5	M_2G_2 (80 ppm MH+ 40ppm GA_3)	17.90	11.58	15.78	9.23	100.60	65468	1:2.86
T_6	M_2G_3 (80 ppm MH+ 60ppm GA_3)	18.70	11.91	16.08	9.37	109.24	72458	1:2.97
T_7	M_3G_1 (100 ppm MH+ 20ppm GA_3)	20.01	12.30	16.37	9.62	113.10	79598	1:3.37
T_8	M_3G_2 (100 ppm MH+ 40ppm GA_3)	20.96	13.03	16.71	10.27	123.85	88698	1:3.52
T_9	M_3G_3 (100 ppm MH+ 60ppm GA_3)	21.30	13.31	17.01	10.85	125.29	88488	1:3.40
T_{10}	Control	12.33	10.42	14.35	7.20	80.85	50050	1:2.62
SEm+-		1.33	0.37	0.40	0.44			
CD at 5% level		4.01	1.12	1.20	1.32			

Conclusion

On the basis of different characteristics in present investigation, it could be concluded that foliar application of growth regulators like Maleic hydrazide and Gibberllic acid have the ability to improve growth parameters and enhance fruiting and yield per plant in okra cv. Varsha Uphar. Among the various plant growth regulator treatments tested, the foliar spraying on the okra variety Varsha Uphar with treatment T_9 M_3G_3 (100 ppm MH + 60 ppm GA_3) found to be optimum for maximization of the fruit yield per plant.

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