Original Research Article

Response of growth and yield of garlic cv. PG-18 against various plant growth regulators and mulching along with its consortium (please mention "along with its consortium" instead of "and its consortium")

ABSTRACT

An investigation was carried out to examine the effect of plant growth regulators and mulching along with their combinations on the growth and yield attributes of garlic at Agriculture Farm, School of Agricultural Sciences & Technology, RIMT University, MandiGobindgarh, Punjab, India during 2019-20by using cultivar PG-18. The study comprised plant growth regulators (GA_3 25 ppm, IAA 40 ppm, and NAA 60 ppm) and mulches (Black polythene mulch and Rice straw mulch) along with a control. The experiment was replicated thrice and subjected to statistical analysis by using RBD at 5% of CD. The results revealed that growth parameters i.e. plant height (56.83 cm), number of leaves/pant (8.00), and stem diameter (7.87 mm) were reported utmost with the application of BPM+GA_3 @ 25 ppm while the longest leaf length (38.59 cm) and diameter of the pseudo stem (4.73 cm) were measured with BPM+NAA @ 60 ppm and SM+NAA @ 60 ppm, respectively.However, maximum number of cloves/bulb (19.33),diameter of cloves (2.93 mm), clove weight (1.73 g), diameter of bulb (4.04 cm), fresh weight (29.96 g),dry weight (10.53 g),yield/plot (480.30 g) and yield/ha (70.21 q) were resulted by BPM+IAA @ 40 ppm.

Keywords: *Garlic, growth, PG-18, plant growth regulators, mulching, and yield.*

INTRODUCTION

Garlic (*Allium sativum* L.) belongs to the family Alliaceae and is one of the main Allium vegetable crops known worldwide with respect to its production and economic value. India is the second largest producer of garlic in the world. In India, the crop is grown in the states of Maharashtra, Himachal Pradesh, Gujarat, Andhra Pradesh, Karnataka, Punjab, and Rajasthan. Garlic is consumed throughout the year by Indian people in one or other preparations [32]. It is one of the oldest cultivated vegetables and the second most widely produced Allium next to onion[13]. The primary center of origin of garlic is Central Asia. Garlic has a wide area of adaptation and cultivation throughout the world. The freshly peeled garlic cloves contain 62.8% moisture, 29% carbohydrate, and 6.3% protein [21].

Plant Growth Regulators are also one of the easiest and cheapest sources to enhance the production of onion to some extent [7]. It has also been reported that foliar application of PGRs stimulates the formation of lateral buds and increases the number of cloves per bulb. The plant bio-regulators comprise both retardants and promoters when it is used in appropriate concentration, much influence the plant architecture in a typical form [35]. Various plant growth regulators are responsible for stimulating cell division, cell elongation, auxin metabolism altering, and cell wall plasticity. They are also known to enhance the source-sink relationship and stimulate the translocation of photoassimilates, thereby increasing productivity [30]. GA_3 plays a vital role in vigorous growth that promoted the total plant length of the onion by 35% of the control and also increased the number of leaves, and fresh and dry weight significantly [19]. Thus, GA_3 has a promoter

effect on the growth and development of bulb crops, as well as the total yield [1]. IAA plays a major role in regulating plant growth; it controls vascular tissue development, cell elongation, and apical dominance in all vegetable crops [41]. NAA has been reported to induce physiological efficiencies including the photosynthetic ability of plants which resulted in better growth and yield of several crops [40].

Mulch provides many advantages for the user, such as higher yield, better moisture retention, reduce fertilizer leaching, decrease soil compaction, and reduce weed infestation, thus offering environment-friendly control of weeds [12]. One of the main objectives of using mulch is to increase soil temperature in the root and bulb zone. The favorable root zone temperature promotes the uptake of water and mineral nutrients, which in turn promotes better growth of plants and biological activity in the soil. As garlic is reproduced exclusively by vegetative means, plant characteristics such as clove weight size used for propagation also affect the quality of the produce, significantly [27]. So, there is a great need to standardize the size of garlic cloves used for propagation, to get cost-effective results in garlic production. So keeping the above facts in mind the current experiment was carried out.

MATERIALS AND METHODS

A field experiment was conducted using garlic cv. PG-18" was conducted at Agriculture Farm, School of Agricultural Sciences & Technology, RIMT University, MandiGobindgarh, Punjab, during 2019-20. In this investigation three plant growth regulators i.e. GA_3 @ 25 ppm, IAA @ 40 ppm, and NAA @ 60 ppm along with straw mulch (SM)and black polythene mulch (BPM) were taken. Total 12 treatments i.e. GA_3 @ 25 ppm, IAA @ 40 ppm, NAA @ 60 ppm, straw mulch, black polythene mulch, SM+GA_3 @ 25 ppm, SM+IAA @ 40 ppm, SM+NAA @ 60 ppm, BPM+GA_3 @ 25 ppm, BPM+IAA @ 40 ppm and BPM+NAA @ 60 ppm along with control were used for this experiment.The experiment was laid out in a factorial randomized block design with three replications. Observations on various growth and yield characters were recorded. Results thus obtained, were subjected to statistical analysis by using OPSTAST.

RESULTS AND DISCUSSION

The results obtained on growth parameters are depicted in table 1. The combined application of plant growth regulators and mulches exerted a significant effect on the growth of garlic plants. The tallest plant (56.83 cm) was recorded with the application of BPM+GA_3 @ 25 ppm followed by NAA @ 60 ppm (56.63 cm) and BPM (56.42 cm). While the shortest plants (46.60 cm) were noticed under control. It is revealed that the increase in the growth of garlic plants due to the application of pre-sowing treatment may be attributed to the improvement of water absorption by the seedling and a positive influence on cell division and cell elongation[38]. This result correlated with the study of past workers [20] and they noticed that the application of mulching in well tilth conditions was found to be the most effective and may be used in the cultivation of garlic. The present findings were corroborated by the previous findings [18]. The application of BPM+GA_3 @ 25 ppm resulted in more leaves/plant (8.00)followed by GA_3 @ 25 ppm (7.83) and BPM (7.44). Whereas, control was found for a lesser number of leaves/plant (5.44).some of past workers stated that growth regulators enhanced the activity of antioxidant enzymes such as ascorbate peroxidase, glutathione reductase, catalase, and peroxidize which increases the number of leaves by protecting plants from a variety of stresses[8]. It has been reported that a higher number of leaves per plant as produced by mulch treatment was possibly due to the supply of optimum moisture to the growing plants [19]. According to some workers, black polyethylene has a positive effect on soil temperature and the differences can be related to this characteristic [25]. The longest leaf length (38.59 cm) was recorded with the application of BPM+NAA @ 60 ppm followed by

BPM (37.84 cm) and NAA @ 60 ppm (26.48 cm). Although, the shortest leaf length (19.60 cm) was measured under control. This is noticed that NAA and GA_3 at 150 ppm increase the vegetative growth of onions. The earlier worker reported the positive effect of plant growth regulators on vegetative growth, yield, and quality of garlic cv. G-282 under i.e. maximum length of leaf, plant height, leaf length, and plant weight with the treatment of NAA @ 325 ppm followed by NAA @ 275 ppm under Iraq condition[10]. The longest leaf length (5.72 cm) as produced by rice straw mulch was possibly due to higher vegetative growth as an effect of optimum moisture supply to the growing plants. Mulches conserved more soil moisture enhancing vegetative growth contributing characters [11]. The findings are in agreement with the results of former workers [5].Treatment BPM+GA_3 @ 25 ppm recorded with greater stem diameter (7.87cm)followed by NAA @ 60 ppm (7.87 cm) and BPM (7.80 cm). On the other hand, control resulted in the shortest stem diameter (4.20 cm). Some scientists also reported that an increase in stem diameter was recorded under 20 ppm of NAA [9]. It has been proved that plant growth regulators and mulching is most effective in improving almost all the growth characteristics of onion. The current findings were corroborated by earlier results[23].The cause of the increment in stem diameter by the accumulation of dry matter inside the plant stem which is due to the application of mulch [16]. Treatment SM+NAA @ 60 ppm was reported for more diameter of pseudo stem (4.73 mm) followed by NAA @ 60 ppm (4.68 mm) and BPM (4.62 mm). Whereas, the lesser diameter of pseudo stem (3.50mm) resulted from control. The present findings were in the line with the results of earlier workers [4, 23, and 12].

Table 2 is containing the findings on the yield parameter.The application of BPM+IAA @ 40 ppm resulted from more calves/bulb (19.33) followed by (18.55) and IAA @ 40 ppm (16.83). Whereas, control was found for a lesser number of cloves/bulbs (10.20).Some of the workers stated that growth regulators enhanced the activity of antioxidant enzymes such as ascorbate peroxidase, glutathione reductase, catalase, and peroxidize which increases the number of leaves by protecting plants from a variety of stresses [8]. The report is showing that a higher number of leaves per plant as produced by mulch treatment was possibly due to the supply of optimum moisture to the growing plants [19]. According to [25] black polyethylene has a positive effect on soil temperature and the differences can be related to this characteristic.[3 and 9] reposted the same findings. Large-sized cloves stored a comparatively large amount of nutrients that help the development of plants immediately after the emergence of seedlings [29].Due to plants used under mulch along with some growth chemicals, the best from the resulted ecological niche under weed free environment resulted in enhanced availability of all the resources to the optimal level and it could transfer more photosynthetic materials to the reproductive organs and it could increase the bulb yield with producing more number of cloves/bulb with higher weight [26].Treatment BPM+IAA @ 40 ppm was recorded for more diameter of pseudo stem (2.93mm) followed by BPM (2.85 mm) and IAA @ 40 ppm (2.36 mm). Whereas, the lesser diameter of pseudo stem (1.50 mm) resulted from control.It is noticed that generally, during maturity, plant biomass increased considerably, however it seems that GA_3 supply leads to vigorous plant growth and yield [6]. Higher yield i.e. the diameter of cloves attributes a positive effect on rice straw mulch on moisture retention, temperature regulation, and weed suppression which positively contributes to the clove attributes [20].This might be attributed due to increasing soil organic matter (grass mulch) and water efficiency by minimizing excess evaporation, regulation of temperature in causing early bulb maturity while not using mulch allowed the plant to have access to adverse conditions like scarcity of water and temperature[22 and 15].Maximum clove weight (1.73 g)was weighed with the application of BPM+IAA @ 40 ppm which was followed by BPM (1.60 g) and IAA @ 40 ppm (1.33 g). While control was recorded with lesser clove weight (0.65g).[24] reported that increased vegetative and bulb growth was observed in large-sized cloves due to more reserved food materials that might have helped in increasing the overall yield of garlic. The result of earlier worker is showing that GA_3 stimulates

both cell division and cell elongation which is responsible for increments of the cells [14].Mulch controls the weeds by smothering seedlings, and preventing daylight which helps foster germination from reaching which is responsible for the overall accumulation of a mass of cells that leads to an increase in weight [2,33 and 23].The present findings were by the results of [26].Treatment BPM+IAA @ 40 ppm recorded with greater diameter of bulb (4.06 cm) followed by BPM (3.98 cm) and NAA @ 60 ppm (3.65 cm). Though, control resulted in a lower diameter of the bulb (2.83 cm) [17 and 6].Black polythene mulch was also reported as statistically significant with straw mulch.The obtained findings were in accordance with the line of previous results [19].This might be attributed due to increasing soil organic matter (grass mulch) and water efficiency by minimizing excess evaporation, regulation of temperature in causing early bulb maturity while not using mulch allowed the plant to have access to adverse conditions like scarcity of water and temperature [12, 22and 15].The maximum fresh weight of the bulb (29.96 g)was weighted with the application of BPM+IAA @ 40 ppm which was followed by BPM (29.29 g) and IAA @ 40 ppm (28.84 g). While control was recorded with the lowest fresh weight of bulb (20.55 g). Past workers revealed that enhancement in the fresh weight of the bulb might be due to the integrated effect of the smallest clove size and the ability of growth regulators to reduce the transpirational losses during storage [32]. These results are in line with the findings of a previous scientist [31and 36].Treatment BPM+IAA @ 40 ppm was recorded with the highest dry weight of bulb (10.53 g) followed by BPM (10.27 g) and NAA @ 60 ppm (9.19 g). Though, control resulted in the lowest dry weight of the bulb (6.56 g).A similar response was also recorded by other workers [34].The application of black polythene mulch was also reported statistically significant with straw mulch. The same results were observed significant variation was reported due to the influence of mulching on the dry weight of garlic bulbs [28 and 37].The maximum yield/plot (480.30 g)was weighted with the application of BPM+IAA @ 40 ppm which was followed by BPM (466.37 g) and IAA @ 40 ppm (461.11 g). While control was recorded with a minimum yield/plot (350.80 g)[36].The results obtained under black polythene mulch were statistically significant with straw mulch. The present findings were corroborated by the findings of former workers [25 and 26].Treatment BPM+IAA @ 40 ppm resulted maximum yield/ha (70.21q)followed by BPM (68.16q) and IAA @ 40 ppm (67.40 q). Although, minimum yield/ha (55.97 q) was resulted by control.According to findings of other workers may be stated that the maximum bulb weight and higher yield per plot and per hectare were recorded from water hyacinth because mulch plays a vital role in moisture conservation that will ultimately enhance the overall yield of the plant[39 and 42].

Conclusion

On the basis of the above findings, it may be concluded that all the growth parameters like plant height, number of leaves/plant, and stem diameter were recorded with the application of BPM+GA_3 25 @ ppm while BPM+NAA @ 60 ppm excreted a positive effect on leaf length and diameter of pseudo stem was significantly affected by SM+NAA @ 60 ppm. All the yield and yield attributing parameters were positively enhanced with the application ofBPM+IAA @ 40 ppm. While all of these parameters responded less against control.

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Table 1: Effect of plant growth regulators and mulching along with its interaction on growth of garlic.

Treatments	Plant height (cm)	Number of leaves/plant	Leaf length (cm)	Stem diameter (cm)	Diameter of pseudo stem (mm)
Control	46.60	5.44	19.60	4.20	3.50
Plant Growth Regulators					
GA_3 @ 25 ppm	55.16	7.83	24.53	5.68	4.31
IAA @ 40 ppm	53.36	6.83	22.53	4.57	4.16
NAA @ 60 ppm	56.63	7.50	26.48	7.87	4.68
SE(m)±	0.38	0.37	0.82	0.55	0.03
CD at 5%	1.23	1.12	1.80	1.17	0.12
Mulching					
SM	54.68	7.33	35.19	4.62	4.15
BPM	56.42	7.44	37.84	7.80	4.62
SE(m)±	0.31	0.3	0.04	0.54	0.03
CD at 5%	1.70	0.9	0.13	1.08	0.10
Interaction					
SM+GA_3 @ 25 ppm	55.16	6.66	35.12	4.61	4.10
SM+IAA @ 40 ppm	52.46	6.66	34.10	4.33	3.61
SM+NAA @ 60 ppm	56.43	7.66	36.37	5.91	4.73
BPM+GA_3 @ 25 ppm	56.83	8.00	37.95	7.87	4.52
BPM+IAA @ 40 ppm	54.26	7.00	37.00	3.82	4.72
BPM+NAA @ 60 ppm	55.16	7.33	38.59	4.68	4.62
SE(m)±	0.54	0.53	0.07	0.87	0.05
CD at 5%	1.62	1.06	0.23	1.50	0.17

Table 2: Effect of plant growth regulators and mulching along with its interaction on yield of garlic.

Treatments	Number of cloves/bulb	Diameter of cloves (mm)	Clove weight (g)	Diameter of bulb (cm)	Fresh weight of bulb (g)	Dry weight of bulb (g)	Yield/plot (g)	Yield/ha (q)
Control	10.20	1.50	0.65	2.83	20.55	6.56	350.80	55.97
Plant Growth Regulators								
GA_3@ 25 ppm	16.00	2.33	1.26	3.60	28.13	9.15	439.70	64.27
IAA @ 40 ppm	16.83	2.36	1.33	3.51	28.84	9.11	461.11	67.40
NAA @ 60 ppm	15.66	2.28	1.25	3.65	28.37	9.19	453.92	66.35
SE(m)±	0.32	0.04	0.04	0.05	0.22	0.15	5.04	0.71
CD at 5%	0.96	0.12	0.06	0.15	NS	0.45	15.13	2.10
Mulching								
SM	13.77	1.80	0.96	3.19	27.60	8.04	431.61	63.09
BPM	18.55	2.85	1.60	3.98	29.29	10.27	466.37	68.16
SE(m)±	0.26	0.03	0.03	0.04	0.18	0.13	6.45	1.42
CD at 5%	0.84	0.11	0.11	0.14	0.57	0.41	19.35	4.21
Interaction								
SM+GA_3@ 25 ppm	13.66	1.83	0.96	3.26	27.26	8.03	436.30	63.78
SM+IAA @ 40 ppm	14.33	1.80	0.94	2.95	27.26	7.70	432.80	63.27
SM+NAA @ 60 ppm	18.33	1.76	1.00	3.36	27.83	8.04	445.20	65.09
BPM+GA_3@ 25 ppm	18.33	2.83	1.56	3.93	29.05	10.28	464.50	67.90
BPM+IAA @ 40 ppm	19.33	2.93	1.73	4.06	29.96	10.53	480.30	70.21
BPM+NAA @ 60 ppm	18.00	2.80	1.50	3.95	28.91	10.00	460.2	67.27
SE(m)±	0.45	0.06	0.06	0.07	0.31	0.22	8.04	1.32
CD at 5%	1.35	0.19	0.19	0.25	0.94	0.66	24.13	3.94