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Stimulatory Effect of GA_3 and IAA on Ripening Process, Kernel Development and Quality of Rice

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Abstract

The application of growth regulators Gibberellic Acid (GA_3) and Indole Acetic Acid (IAA) at panicle emergence stage/just at flowering stage affected the plant height, number of tillers per pot, sterility (%), number of spikelets per panicle and paddy yield significantly. Maximum reductions in sterility (%) was recorded in IAA and GA_3 applied at panicle emergence stage as compared to check (control). The reason for this might be the delayed senescence and prolonged functionality plant leaves, allowing the vital physiological processes of the plant like photosynthesis and translocating to carbohydrate for a longer period of time as compared to the pots where no growth regulator was applied.

Introduction

Rice (*Oryza sativa* L.) is the most important food crop of the world. Due to large number of people subsisting on rice, its annual out put must increase by over 5 million tones a year just to keep pace with population growth (IRRI, 1985). The major role played by rice as food is unlikely to diminish in the foreseeable future. At present its role in the world trade seems to be certain and its demand in the international market would be well sustained for many years to come. Its role will be more positive and conspicuous if the quality of kernel is further improved to attract the international as well as the national customers.

In this light the need is felt to focus attention on the research activities relating to improving the filling of the spikelets and quality of kernel without lowering the yield. Ill ripening, including sterility, abortiveness, opaqueness and many other types of chalkiness are undesirable characteristics of kernel which extremely impair and deteriorate its quality. Some research work relating to the problem has been reported (Nagato and Chaudhry, 1969; Nagato *et al*., 1971) but many of the related ill-ripening and chalkiness of kernel were not well understood. It was therefore, contemplated to tackle the problem of ill-ripening and chalkiness through a multidimensional approach laying out some most appropriate experiments which could have exerted some influence and help decrease the severity of the problem.

The plant characteristics can be modified to a certain degree by the application of growth regulators. The appropriate concentration of growth regulators like gibberellin (GA_3) can stimulate the activity of key chemical substances and physiological processes which are reflected by increased growth and ultimate increased yields of high quality (Huffaker, 1965). Different plant growth regulators were therefore, applied to rice plant to see their effect on enhancing the photosynthetic activities of the leaves and other growth characters (Jones, 1973) which may exert a favourable effect on the yield and quality of rice kernel.

Materials and Methods

The trial was conducted at Gomal University, D.I. Khan during 1994-95, in the soil filled pots each having 240 m diameter and 300 mm depth. The experiment was carried in a Completely Randomized Design with four replication before filling the pot, the soil mixed thoroughly with 0.5 N, 0.4 g P_2O_5 and 0.27 g K_20 per pot for coarse rice varied IR-6. Similarly 0.4 g N, 0.27 g P_2O_5 and 0.27 g K_20 per pot were applied to fine rice variety Basmati-370. The source of fertilizers were urea, single supper phosphate potassium sulphate for both varieties. Three seedling was transplanted in each pot. Aqueous solution of GA_3 and IAA were sprayed at the rate of 3 ml/plant at panicle initiation stage.

The data was analysed statistically using Analysis Variance Techniques (Steel and Torrie, 1980) and Duncan multiple Range Test was used to see the significance treatment means at 5% level of probability (Duncan, 1955).

Results and Discussion

Plant height at maturity (cm): The data regarding the plant height are given in Table 1. It is clear from the data that plant height was affected by the growth regulators as well as variety during both the years. Fine rice variety, Basmati-370 produced plants of substantially more height than coarse rice variety, IR-6. As regards application of growth regulators, the plants of more height were produced in (GA_3) and T3 (1AA) over control, during the years. The intact cells elongation, resulted in elongated intern of the plant stem (Dey, 1980).

Number of tillers per plant: The data given in Table 1 indicated that variety IR-6 produced more number of tillers than the than fine rice variety Basmati-370, during both the year Among the treatments, T_2 (GA_3) and T_3 (IAA) result 12.41 and 12.47 tillers per hill during 1994 and 13.08, 12.75 tillers per hill during 1995 respectively, as compare

Table 1: Effect of plant growth regulators during the year 1994 and 1995

	1994			1995		
	IR-6	Bas-370	Mean	IR-6	Bas-370	Mean
Plant height						
T_1	80.75	147.08	113.91c	81.84	149.80	115.81c
T_2	92.46	179.65	136.05a	96.26	171.47	133.86a
T_3	89.43	170.19	129.81b	88.94	150.32	119.63b
Means	87.54b	165.64a		89.01b	157.19a	
Number of tillers/plant						
T_1	12.31	7.47	9.89c	12.61	7.32	9.97b
T_2	15.56	9.26	12.41b	15.73	9.21	12.47a
T_3	16.21	9.82	13.07a	16.15	9.35	12.75a
Means	14.69a	8.85b		14.83a	8.62b	
Number of spikelets/panicle						
T_1	103.18	121.08	112.13c	105.23	120.76	112.99c
T_2	113.65	135.64	124.64b	114.76	137.91	126.33b
T_3	116.60	140.32	128.46a	116.28	141.80	129.04a
Means	111.14b	132.34a		112.09b	133.49a	
Sterility percentage						
T_1	9.70	11.88	10.79a	09.58	09.92	09.75a
T_2	7.65	09.05	08.35b	07.68	08.91	08.30b
T_3	6.99	08.19	07.59c	06.67	07.89	07.28c
Means	08.11b	09.70a		07.97b	08.90a	
Normal kernel (%)						
T_1	84.97	82.54	83.75b	85.32	84.95	85.13c
T_2	88.76	86.61	87.68a	87.88	87.23	87.55b
T_3	89.17	88.72	88.94a	89.64	89.91	89.65a
Means	87.63a	85.95b		87.61a	87.36a	
Paddy yield/pot (g)						
T_1	23.08	17.97	20.52c	23.20	17.83	20.51c
T_2	37.86	22.76	30.31b	38.70	23.07	30.92b
T_3	39.94	24.85	32.39a	04.11	25.29	32..70a
Means	33.62a	21.85a		22.00b	22.06b	
Protein content (%)						
T_1	7.32	8.17	7.74b	7.45	8.22	7.83b
T_2	7.78	8.87	8.32a	7.81	8.95	8.38a
T_3	7.82	8.92	8.37a	7.88	9.05	8.46a
Means	7.64b	8.65a		7.71b	8.74a	

Means sharing a letter in common are statistically non-significant at 5% level of probability

to 9.89 and 9.97 obtained in T_1 (Control) during the same years. The differences among the varieties and treatments however, could not reach the level of significance when compared with each other. Results agreed with those of Harda *et al*. (1986) who reported that GA_3 increased the number of tillers per plant.

Number of spikelets per panicle: It is evident from the data down in Table 1 that the rice variety, Basmati-370 produced more number of spikelets per panicle (132.34 and 133.49) as compared to coarse rice variety, IR-6 (111.14 and 112.09) respectively. The mean values show that both the GA_3 and IAA produced more number of spikelets per panicle as compared to check (control) during both the years. The auxin (IAA) exerts influence on plant growth in many ways, including cell enlargement or elongation, flower initiation and development and fruit setting. The gibberellin hormones have many regulatory functions. The most obvious is the stimulatory effects on stem growth and flowering. Gibberellin may stimulate cell division, cell elongation and can control enzyme secretion. Debate and Murty (1981) and Singh and Singh (1982) claimed that the application of IAA delayed leaf senescence, in terms of enhanced functional leaf area, and increased the number of spikelets per panicle.

Sterility percentage: It is clear from the data given in Table 1 that Basmati-370 resulted in more sterility (9.70 and 8.90%) as compared to 1R-6 (8.11 and 7.97%) during both the years. It is very interesting to note that the sterility

which is a serious problem, reducing the rice yield and deteriorating its quality, can be controlled to a considerable extent with the use of appropriate growth regulators applied at appropriate time. The minimum sterility (2.59 and 7.28%) was recorded in treatments T_3(IAA) and T_2(GA_3) (8.85 and 8.30%) during the years. Both the growth regulators GA_3 and IAA exerted an influence on plant growth and development. They caused the cell enlargement and helped in flowering and consequent grain development, and also reduced the sterility percentage by improving fertilization. Similar results were reported by Singh *et al*. (1984), who observed that GA_3 and 1AA spraying at anthesis increased percentage of filled spikelets.

Normal kernels (%): Normal kernels do not stop growing in the way and attained normal dimension, normal starch compaction and full weight. The data regarding normal kernels are presented in Table 1. Coarse rice variety, IR-6 produced more normal kernels (87.62 and 87.93%) as compared to fine rice variety, Basmati-370 (85.33 and 86.34%) respectively during the both years. Among the treatments, T_3(IAA) produced maximum normal kernels (88.93 and 88.26%) which do not differ statistically from T_2(GA3) (87.77 and 88.03%) during both years respectively. The reason for obtaining more normal kernels incase of treated pots may be due to the fact that leaves in treated pots remained functional for a longer period of time on account of delayed senescence in these pots (Singh and Singh, 1982). The second reason might be the longer functionality of the vascular bundles in different parts of the panicle which might have resulted in an efficient translocation of photosynthates (Debata and Murty, 1981; Singh *et al*., 1984).

Paddy yield per pot (g): The data pertaining to paddy yield/pot are given in Table 1. The coarse rice variety, IR-6 produced more paddy yield (33.62 and 34.02 g) than the fine rice variety, Basmati-370 (21.85 and 22.06 g) respectively. The variation might be due to more breadth and thickness of the kernel of this variety which may be genetically controlled. Among the growth regulators, T_3(1AA) resulted more paddy yield (32.39 and 32.70 g) followed by T_2(GA_3) (30.31 and 30.92 g) during the years. The control treatment produced minimum paddy yield (20.52 and 21.51 g). It may again by explained in terms of more efficient functionality of the stem, leaf sheath and leaves which might have positively helped to increase the efficiency of the plant for physiological and vital functions particularly the photosynthesis and translocation of photosynthates because of the fact that senescence of leaves was delayed in the treated pots, whereas, the leaves were dried in check pots sooner. Another reason for more paddy yield in treated pots may be the more panicles, spikelets, lesser occurrence of sterility, abortive and opaque kernels and more normal kernels obtained during 1994 and 1995 respectively. The study documented that application of IAA was absolutely necessary for having improvement final yield as evidenced by Dey (1980).

Protein content (%): The data regarding protein content are shown in Table 1. It is obvious that fine rice varied Basmati-370 produced more protein content as compared to coarse rice variety, IR-6 during both the years. The reason for obtaining more protein content in case of and IAA may be due to the fact that the leaves remain functional for longer period of time and played vital role the synthesis of protein contents. Similar responses were further documented by Hack *et al*. (1985) who claimed that application of plant growth regulator increased yield improved quality of rice.

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