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Genetic Variation in Wheat for Response to Different Growth Hormones

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ABSTRACT

These studies were carried out to ascertain the effect of gibberellic acid, Indole-3-acetic acid and TIBA on germination, shoot length and root length of five wheat genotypes viz., Inqilab-91, LU-26S, 6500, 4072 and 5039. All three hormones were applied as pre-treatment in concentrations of 100, 500 and 1000 ppm. Germination, shoot length and root length were enhanced by these hormones in most of the cases for all cultivars except one i.e., 5039. This cultivar (5039) could be used in the breeding program to develop high yielding wheat cultivars as it is the best source of genes controlling the production of these growth hormones. Seed germination percentage could be used as selection criteria for response to selection as it has high heritability as compared to other traits.

Key Words: Wheat; Growth hormones; Germination; Shoot length; Root length

INTRODUCTION

Among all the cereals wheat is the foremost important crop being used as a staple food on global basis. It accounts for 20% of the total food calories consumed by human population (Langer & Hill, 1962). Pakistan's economy primarily depends upon good harvest of wheat crop, which is annually grown on an area of 8.38 million hectares with grain production of 18.63 million metric tones (Anonymous, 1998). Almost every year a huge amount of foreign exchange is spent on wheat import to meet the dietary need of our people. Keeping in view its immense importance, there is no exaggeration in saying that the prosperity of an agricultural country primarily depends upon good harvest of wheat crop. Thus, its growth should be enhanced through the employment of various techniques such as use of improved cultivation, better management practices, diseases and pest resistant varieties, fertilizers and application of growth regulators. Hormones play a vital role in the control of growth not only within the plant as a whole but also within its individual organs (Wareing & Philips, 1978). In wheat, application of gibberellic acid promotes hypocotyl growth, seed germination and cell division in cambial zone; Indole-3-acetic acid (IAA) stimulates cell enlargement, vascular tissue differentiation, root initiation, growth of floral parts, etc. Root and shoot lengths were increased by 10^{-6} M concentration of all growth regulators (Dogra & Thukri, 1991). Heritability estimates are efficiently used to measure response to selection for improvement of various plant parameters, ultimately the yield (Mather & Jinks, 1977).

The present studies were carried out to have information on the comparative effectiveness of optimal concentrations of different plant growth hormones on different cultivars of wheat. This information could play a vital role to increase wheat productivity through the selection of desirable wheat varieties and application of effective growth hormones doses.

MATERIALS AND METHODS

These studies were carried out in a laboratory experiment in the Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad. In this experiment, the growth substances (Gibberellic acid, GA), (Indole acetic acid, IAA) and TIBA were used to study their effect on the germination, shoot length and root length of wheat genotypes viz., Inqilab-91, LU-26S, 6500, 4072 and 5039. The seeds were soaked in growth substances solutions having (100, 500 and 1000 ppm) concentrations for each of the hormone. Separate germination trays were used with three replications/genotype/treatment. After soaking, the trays were placed in an incubator at 25°C for 24 hours. Then these were placed for germination at 14°C. During germination, distilled water was used to maintain the required moisture level. The rate of germination was recorded daily up to 10 days, after which root and shoot length were measured. The data obtained were subjected to analysis of variance for split-split plot experiment under CRD with concentration of hormones as most important in the sub-sub plot and the genotypes as least important in the replication or main plot. Heritability estimates were also computed following the formula used by Burton and Devane (1953).

RESULTS AND DISCUSSION

The germination process was considered to be completed with the emergence of both radicle and plumule. The analysis of variance indicates that mean differences for germination are highly significant at genotypic as well as treatment level. All the interactions were also significant for

their traits (Table I). For shoot length, it was non-significant for varieties; interaction of genotypes with hormones, interaction of genotypes with concentrations and interaction of genotypes with hormones and their concentrations; while it was highly significant for remaining factors and their interactions. It means genotypes showed no difference i.e., their behavior is similar and show no interactions with hormones, their concentrations and interaction with both. Analysis of variance for root length was significant for genotypes and hormones concentrations, highly significant for hormones and interaction between hormones and their concentrations, while non-significant for the remaining factor interactions.

GA effect on germination, shoot length and root length. Pre-treatment with all three concentrations i.e., 100, 500 and 1000 ppm enhanced the germination of all the genotypes as compared with control except one genotype i.e., 5039, although the germination was also affected at 1000 ppm in case of 4072. The highest germination percentage of genotypes 6500 and LU-26S was at 100 ppm of GA, for genotype 4072 at 500 ppm, for genotype Inqilab-91 at 1000 ppm and for genotype 5039 at 0 ppm of GA (Table II). This may be due to genetic differences and genotypic interaction with GA. This pretreatment also enhanced the growth of shoot length of all the genotypes except 5039. Highest shoot length was at 100 ppm in LU-26S, at 500 ppm in Inqilab-91, in 5039 (equal to control) whereas in 4072 the effectiveness was not so prominent, and at 1000 ppm in 6500 (Table II). Generally, GA application promoted shoot length.

Pre-treatment of GA with all three levels enhanced the growth of root length except in 5039 and LU-26S. Highest root length was, at 500 ppm in Inqilab-91 and 4072, at 1000 ppm in 6500, however in 5039 and LU-26S root length at 0 ppm was higher than treatment application (Table II). So generally, it promoted root growth. These results are in accordance with the findings of earlier workers like Lin (1985), Ahmad *et al.* (1986), Parasher and Verma (1988), Dogra and Thukri (1991), Liu *et al.* (1991) and Montague (1995).

IAA effect on germination, shoot length and root length. Pre soaking of wheat seeds with all three levels of IAA enhanced the germination of all the genotypes except 5039 as compared to control (Table II). Highest germination was at 100 ppm in Inqilab-91 followed by LU-26S and 6500, at 1000 ppm. Generally, IAA has positive effects on germination. Pretreatment also enhanced shoot length except in 5039 (Table II). The highest shoot length was measured at 500 ppm in LU-26S followed by 4072 at 100 ppm. Pretreatment of IAA with all three levels also enhanced the root growth in most of the cases at 100 ppm. Highest root length was measured at 500 ppm in 5039; whereas significant increase in root

Table I. Mean square values for germination, shoot length and root length of wheat

Source of variation	d.f.	Germi–nation (%)	Shoot length	Root length
Genotypes	4	3808.2**	22.5^{NS}	19.6*
Error 1	10	29.8	9.6	3.3
Hormones	2	406.1**	56.1**	26.9**
G x H	8	81.2**	1.2^{NS}	0.9^{NS}
Error 2	20	17.4	1.4	0.6
Concentration	3	153.2**	21.9**	3.7*
G x C	12	242.4**	3.4^{NS}	2.0^{NS}
H x C	6	153.0**	14.0**	8.2**
G x H x C	24	78.0**	2.3^{NS}	1.01^{NS}
Error 3	90	26.2	2.1	1.07

G= Genotypes; H= Hormones; C= Concentration; NS= Non significant; *= Significant at 5% level of probability; **= Highly significant at 1% level of probability

Table II. Effect of different growth hormones on germination, shoot length and root length of wheat

Dose (ppm)	Inqilab-91			LU-26S			6500			4072			5039		
	G %	S (cm)	R (cm)	G %	S (cm)	R (cm)	G %	S (cm)	R (cm)	G %	S (cm)	R (cm)	G %	S (cm)	R (cm)
Gibberellic acid															
0	62.7	3.2	1.8	84.3	5.2	4.3	72.6	4.9	2.7	64.7	3.8	2.1	96.0	6.7	3.7
100	72.6	3.2	1.4	92.1	7.3	3.7	78.5	4.1	1.9	58.8	4.6	1.6	84.3	4.7	2.3
500	68.6	5.8	2.6	76.5	6.3	3.3	74.5	5.5	2.7	68.6	6.1	3.2	94.1	6.7	2.6
1000	74.5	4.6	1.2	86.3	6.3	2.8	70.6	5.6	2.8	39.2	3.3	0.9	80.4	4.2	1.1
Indole-3-acetic acid															
0	62.7	3.2	1.8	84.3	5.2	4.3	72.6	4.9	2.7	64.7	3.8	2.1	96.0	6.7	3.7
100	90.2	5	3.5	84.3	7.0	4.0	74.5	5.4	2.4	70.6	7.0	3.3	88.2	5.6	2.6
500	74.5	4.1	1.5	82.4	7.9	3.4	74.5	4.8	2.2	62.7	4.8	2.0	94.1	5.4	4.6
1000	82.4	4.6	1.03	88.2	7.0	2.3	74.5	5.0	1.9	72.6	4.2	1.2	94.1	5.2	1.4
TIBA															
0	62.7	3.2	1.8	84.3	5.2	4.3	72.6	4.9	2.7	64.7	3.8	2.1	96.0	6.7	3.7
100	76.5	7.4	3.9	84.3	9.8	6.6	76.5	8.6	4.2	68.6	7.5	3.6	88.2	7.3	3.3
500	74.5	5	1.8	78.5	7.7	4.7	66.7	7.3	4.1	58.8	6.1	2.5	78.5	6.3	2.9
1000	76.5	8.7	4.1	86.3	7.5	5.0	74.5	8.7	4.1	56.8	7.7	4	74.5	8.2	4.0

G= Germination, S= Shoot length, R= Root length

length was also at 100 ppm in case of Inqilab-91 and 4072. These results are similar to those of Harvinder and Dara (1971), Kumar and Baijal (1988), Dogra and Thukri (1991), Singh and Saxena (1991) and Liu *et al.* (1991).

TIBA effect on germination, shoot length and root length. Pretreatment of wheat seeds with all three levels of TIBA enhanced germination except in 5039, while at 500 ppm germination percentage was lower than control in 6500, 4072 and LU-26S (Table II). Maximum germination percentage was recorded at 100 ppm in 6500 and 4072, at 1000 ppm in Inqilab-91 and LU-26S. Pretreatment also promoted the shoot length in all the varieties. Maximum shoot length was measured at 100 ppm in LU-26S and in remaining four genotypes at 1000 ppm. Pretreatment enhanced the root length at all three levels in all the cultivars used in the experiment. The highest root length was measured at 100 ppm in LU-26S and 6500, at 1000 ppm in Inqilab-91, 5039 and 4072; while in 5039 root length was less than control at 500 ppm. These results are in agreement with the findings of Wareing and Philips (1978), and Dogra and Thukri (1991).

Heritability. Broad sense heritability estimates indicated that the trait germination percentage possessed the highest value (97.69%; Table III). In case of root length, heritability estimates are moderate; whereas, the heritability value is low for shoot length. These results show that seed germination could be used as selection criteria for response to selection in case of these hormonal effects on these seedling traits of wheat plant. However, selection based on the broad sense heritability estimates should be made carefully as environmental variation is also a component of variance for the trait considered to be a selection criterion to make improvement based on germination percentage.

Table III. Heritability (broadsense) estimates for germination, shoot length and root length

Components of variation	Germination	Shoot length	Root length
Genetic variance	104.9562	0.3593	0.4547
Phenotypic variance	107.4402	1.1563	0.7257
Heritability (%)	97.6900	31.0700	62.6600

CONCLUSION

From the above results, it could be concluded that these hormones with solution concentration of 100 ppm have positive effects on wheat seedling traits in most of the cases. However, genotype 5039 was negatively affected as it possessed the highest mean values at control showing the inherent ability to produce vigorous seedling with high germination percentage.

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