Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
www.phytojournal.com
JPP 2020; 9(5): 3071-3075
Received: 05-07-2020
Accepted: 08-08-2020

Deepanshu
Department of Horticulture, Allahabad School of Agriculture, Sam Higginbottom Institute of Agriculture, Technology and Sciences, Formerly Allahabad School of Agriculture Institute, Deemed–To-Be-University, Allahabad, Uttar Pradesh, India

Dr. Devi Singh
Department of Horticulture, Allahabad School of Agriculture, Sam Higginbottom Institute of Agriculture, Technology and Sciences, Formerly Allahabad School of Agriculture Institute, Deemed–To-Be-University, Allahabad, Uttar Pradesh, India

Corresponding Author:
Deepanshu
Department of Horticulture, Allahabad School of Agriculture, Sam Higginbottom Institute of Agriculture, Technology and Sciences, Formerly Allahabad School of Agriculture Institute, Deemed–To-Be-University, Allahabad, Uttar Pradesh, India

Genetic variability, heritability and correlation studies on onion (*Allium cepa.* L). genotypes

Deepanshu and Dr. Devi Singh

Abstract
The present investigation on "Genetic Variability, Heritability and Correlation Studies on Onion *(Allium cepa L.)* Genotypes" was conducted in Allahabad, Uttar Pradesh, India on fourteen (14) genotypes of onion for selecting superior onion genotypes. The phenotypic coefficient of variation (PCV) was higher than the genotypic coefficient of variation (GCV) for all traits. Traits like plant height (0.928cm), leaf height (0.935cm), number of leaves (0.604), plant girth (0.795cm), leaf girth (0.857cm), biomass yield per plant (0.9761gm), bulb weight per plant (0.993gm), number of scales (0.823), bulb size in diameter (0.826mm) showed positive correlation with bulb yield per plot. The gross yield had strong positive correlation with bulb diameter. Higher genetic advance was found in high for biomass yield per plot(gm), bulb weight per plot (kg), where as high heritability and high genetic advance (as percent of mean) was recorded for the traits like biomass yield per plant (gm), bulb weight per plant (gm), bulb yield per plot (kg) and except plant height (cm), leaf height (cm), number of leaves, plant girth (cm), leaf girth (cm), bulb size in diameter (mm), number of scales.In view at the contribution of traits towards bulb yield, selection on basis of horticultural traits viz, bulb weight and bulb yield per plot would be a paying preposition in the genotypes included in the study.

Keywords: Onion, GCV, PCV, heritability, genetic advance, correlation

Introduction
Onion (*Allium cepa* Linn.) is one of the important commercial vegetable crops grown in India. It is widely grown in different parts of the country mainly small and marginal farmers as this is labor intensive crop. The demand of onion within the country is all the year round as also demand from exporters makes it essential to maintain supplies of fresh onion all the years round either from fresh harvest or from stores stocks. India's production of onion is estimated to be approximately 55 lakh MT for the year 1999-2000. This quantity is enough to meet the present domestic requirement as well as export of onions. However, to maintain the stability in prices and supplies, proper planning for production, post-harvest handling storage as well as marketing is essential. A global review of area and production of major vegetables shows that onions ranks second in area of vegetables and third in production in the world. As per F. A. O., 1997 report the world production of onion was 38.02 million tones from 2.28 million ha with china being the first in area and production (0.451 million ha and 10.03 million tones) and India second (0.405 million ha. And 4.30 million tonnes (1997).

The productivity of onion is reported highest in Korea (61.9t/ha) followed by China (61.76/t/ha), Australia (44.51t/ha), while in india it is only 10.62 t/ha. The main reason for low productivity in India is practicing of tradition cultivation methods and use of local varieties. In India, Maharashtra, is the leading onion growing state followed by Gujarat, Orissa, Karnataka, U. P., Tamil Nadu, Bihar and Rajasthan. The productivity of onion is, however, highest in Gujarat (27.06t/ha) followed by Punjab (19.68 t/ha). The state wise NHRDF estimates on area and production for 2012-2013.

Onion is known to have many important medicinal and therapeutic effects such as blood sugar lowering, antiplatelet aggregation, fib rinolytic effects. Bulb juice is used as smelling agent an hysterical convulsions and faintness. The nutritive values of onion varies among the varieties and generally 100 g of edible bulb contains moisture (86.8 g), carbohydrates (11.0 g), protein (1.2 g), fibre (0.6 g), minerals (0.4 g), calcium (180 mg), phosphorus (50 mg), vitamin C (11 mg), iron (0.7 mg), nicotinic acid (0.4 mg) and a little of thiamine. Although, onion has low nutritional value (average nutritional value = 2.06), it is one of the most widely used vegetable due to its flavoring and seasoning the food, both at mature and immature bulb stage. Besides, it is being used as salad and pickle. To a lesser extent, it is used by processing industry for dehydration in the form of onion flakes and powder, which are in great demand in the world mark et. In the world, India ranks first in total area and

second in production after China and third after Netherlands and Spain in export. Indian onions is being exported to Malaysia, Singapore, Gulf Countries, Sri Lanka, Bangladesh, Pakistan and Nepal. At present, in the world, onion occupies an area of 297 million ha with the production of 51.91 million tonnes and average productivity is 17.47 tonnes per ha (Anon., 2005). In our country, it is being grown on an area of 0.52 million ha with a production of 6.5 million tonnes and the productivity is 12.50 tonnes per ha. Most of the on ion produced in India comes from Maharashtra, Gujarat, Karnataka, Orissa, Uttar Pradesh and Andhra Pradesh. Karnataka alone occupies an area of 1.24 lakh ha with a production of 6.93 lakh tonnes with an average productivity of 5.60 tonnes per ha (Anon., 2005). The major onion producing districts of Karnataka are Dharwad, Bijapur, Gadag, Chitradurga, Haveri, Davanageri and Bellary.

Onion is an outstanding diploid biennial vegetable that shows severe inbreeding depression. Crossing among divergent groups shows significant improvement in traits. The discovery the cytoplasmic male sterility in onion (Jones and Clarke, 1943) enabled for commercial hybrid seed production and at present hybrid onions have dominated over the conventional varieties in the western countries owing to improved yield and quality of bulb. There is a growing interest on use of onions in food industries for canning and dehydration. Hence, there is a urgent need to develop cultivars suitable for processing industry.

Information on the nature and extent of genetic variability and degree of transmission of traits is of paramount importance in enhancing the efficiency of selection. However, knowledge of correlations among various characters and their relative contribution to yield is useful for multiple trait selection. The present investigation was undertaken to assess the magnitude of genetic variability and heritability of important economic characters, interrelationships among themselves and their effect on yield in a collection of onion *(Allium cepa* L.) varieties. of variation following Burton (1952). The heritability in broad sense and expected genetic advance were computed as per Johnson *et al.* (1955) [11]. The correlation coefficients were determined according to Miller *et al.* (1958) [1].

Materials and methods

The experiment was conducted in the Vegetable Research Farm, Department of Horticulture, Allahabad School of Agriculture Sam Higginbottom Institute of Agriculture, Technology and Sciences, Allahabad (Uttar Pradeah) during 2011-2012. All the facilities necessary for cultivation, including labour were made available in the department.

Allahabad is situated at an elevation of 78 metres above sea level at 25.87 degree North latitude and 81.15 degree E longitude. This region has a sub-tropical climate prevailing in the south-east part of U.P. with both the extremes in temperature, i.e. the winter and the summer. In cold winters, the temperature sometimes is as low as 32°F in December – January and very hot summer with temperature reaching upto 115°F in the months of May and June. During winter, frosts and during summer, hot scorching winds are also not uncommon. Name of different genotypes L-28, VL-67, VL-3, L-355, Red creole Super fursungi, AFLR, U-102, LR-241, Local-1, U-103, AFDR, U-101, N-53. The present experiment was conducted in Randomized Block Design with 14 treatments. The treatments are replication three times. Observations recorded Plant height (cm), Leaf height (cm), Number of leaves per plant, Plant girth (cm),. Leaf girth (cm), Biomass yield/ plant(g), Bulb weight (g), Number of scales/ bulb, Bulb size diameter (mm), Bulb yield / plot (kg).

Results and discussion

The present investigation entitled "studies on genetic variability, heritability and correlation coefficient in onion (*Allium cepa*)" was conducted during November 2012 to April 2013 at the horticulture research farm, department of Horticulture, Sam Higginbottom Institute of Agriculture, Technology and Sciences (Deemed to be university), Allahabad. The experiment was carried out on 14 genotypes of onion. The result obtained for genotype and phenotype coefficient of variation, heritability in broad sense, genetic advance, genetic advance as percent of mean, correlation coefficient analysis of these traits with yield have been discussed below.

Significant difference among genotypes for all the traits showed wide range of variability in the material. The estimate of phenotype coefficient of variation was higher that the genotype coefficient of variation for all the traits. Heritability in broad sense was noticed high for all the traits except plant girth (cm).

The plant height ranged from AFDR (63.58cm) to L-355 (54.16cm) at 120 DAT with mean 58.58. The plant height ranged from AFDR (51.44cm) to L-355 (39.21cm) at 120 DAT with mean 45.79. The number of leaves ranged from AFDR (8.80cm) to L-355 (6.73cm) at 120 DAT with mean 7.54. The plant girth ranged from AFDR (2.27cm) to L-355 (1.95cm) at 120 DAT with mean 2.12. The leaf girth ranged from AFDR (1.45cm) to VL-67 (1.21cm) at 120 DAT with mean 1.34. The biomass yield per plant ranged from AFDR (134.00cm) to L-355 (84.93cm) at 120 DAT with mean 104.41. The bulb weight per plant ranged from AFDR (106.53cm) to L-355 (73.40cm) at 120 DAT with mean 90.55. The bulb yield per plot ranged from AFDR (2.40cm) to L-355 (1.53cm) at 120 DAT with mean 1.96. The bulb size in diameter ranged from AFDR (63.85cm) to L-355 (48.51cm) at 120 DAT with mean 54.89 The scales per bulb ranged from AFDR (8.33cm) to L-355 (6.13cm) at 120 DAT with mean 7.10 given in table 1.

Higher genotypic coefficient of variance (GCV) was observed for bulb yield per plot (kg) (14.020) followed by biomass yield per plot (13.897), while low value of GCV was observed for plant girth (3.931 cm).Higher phenotypic coefficient of variance (PCV) was observed for bulb yield per plot (kg) (14.125) followed by biomass yield per plot (13.920), while low value of PCV was observed for plant girth (5.254 cm). One characters were exhibited highest value of heritability are biomass yield per plant (0.997gm) where as minimum value of heritability was exhibited by plant girth (0.453cm). Higher genetic advance at 5 % was observed for biomass yield per plant (gm) (29.841gm) followed by bulb weight per plot (18.182gm), where as minimum was observed in leaf girth (0.087cm). Higher genetic advance as percent of mean at 5 % was observed for bulb yield per plot (kg) (28.664kg) followed by biomass yield per plot (28.58gm), where as minimum was observed in plant girth (5.45cm). High heritability coupled with genetic advance as percent of mean (% of mean) were observed for characters like biomass yield per plant, bulb weight per plant, bulb yield per plot given in table 2.

The correlation values among the yield components showed that bulb weight per plant had positive correlation with the scales per bulb (0.9947), bulb size in diameter (0.9896), bulb yield per plot (0.9934) at genotypic level in table: 3. At phenotypic level bulb weight per plant had positive

correlation with the scales per bulb (0.7424), bulb size in diameter (0.7537), bulb yield per plot (0.9347) in table: 4. The correlation values among the yield components showed that scales per bulb had positive correlation with the bulb size in diameter (0.9745), bulb yield per plot (0.8232) at genotypic level in table : 3. At phenotypic level scales per bulb had positive correlation with the bulb size in diameter (0.7548), bulb yield per plot (0.8119) in table: 4.

Table 1: Mean Performance of 10 character in onion genotypes.

S. No.	Character	Plant height (cm)	Leaf height (cm)	No. of Leaves	Plant girth (cm)	Leaf girth (cm)	Biomass yield/ Plant (gm)	Bulb weight/ Plant (gm)	Bulb yield/ Plot (gm)	Bulb size in Diameter/ Plant (mm)	Scales/ Bulb
	Line-28	59.3800	46.2067	7.7333	2.2000	1.3667	105.3333	95.8667	2.0700	55.4433	7.0667
	VL-3	55.6067	43.5933	7.2000	2.0133	1.2800	92.2000	80.1333	1.6700	51.6900	6.5333
	AFLR	58.0400	46.0000	7.5333	2.0867	1.3200	97.1333	86.7333	1.8700	54.4100	7.4667
	Local-1	59.7933	46.7267	7.3333	2.1867	1.3667	113.4000	97.2000	2.2000	55.9867	7.6000
	NRCO-1	56.3267	44.1000	6.7333	2.0200	1.2800	94.9333	82.8000	1.7300	52.5800	6.6667
	VL-67	55.4600	42.4400	7.4667	2.0067	1.2133	86.0000	78.2000	1.6100	50.6467	6.4667
	LR-241	61.5800	47.6133	7.2000	2.1933	1.4133	119.9333	97.5333	2.2700	56.7033	7.5333
	AFDR	63.5867	51.4467	8.8000	2.2733	1.4533	134.0000	106.5333	2.4000	63.8500	8.3333
	N-53	63.0933	49.4267	8.3333	2.2333	1.4333	124.9333	99.0667	2.3300	59.5467	7.8667
	U-103	56.4133	45.6467	7.1333	2.0533	1.2933	96.6000	86.0667	1.8300	53.4000	6.7333
	L-355	54.1600	39.2133	7.7333	1.9533	1.4000	84.9333	73.4000	1.5300	48.5133	6.1333
	U-101	58.9667	46.1800	7.2000	2.1533	1.3400	102.0667	95.2000	2.0000	55.4000	7.0000
	NRCO-2	59.4533	46.3667	7.7333	2.1933	1.3667	109.8000	96.2667	2.1300	55.4633	7.2000
	U-102	58.3067	46.1667	7.5333	2.1133	1.3600	100.5333	92.8000	1.9300	54.9267	6.9333
	Mean	58.5833	45.7948	7.5476	2.1200	1.3490	104.4143	90.5571	1.9693	54.8971	7.1095
	C.V.	2.4233	1.5361	5.4445	4.3232	4.1425	0.8020	3.3229	1.7249	5.8471	5.3844
	F ratio	12.1041	52.4417	4.8369	3.4799	4.2667	901.8193	29.5247	199.1786	4.1221	7.4136
	F Prob.	0.0000	0.0000	0.0003	0.0033	0.0008	0.0000	0.0000	0.0000	0.0010	0.0000
	S.E.	0.8196	0.4061	0.2373	0.0529	0.0323	0.4835	1.7373	0.0196	1.8532	0.2210
	C.D. 5%	2.3826	1.1806	0.6897	0.1538	0.0938	1.4054	5.0503	0.0570	5.3873	0.6425
	C.D. 1%	3.2209	1.5960	0.9323	0.2079	0.1268	1.8998	6.8273	0.0771	7.2827	0.8685
	Range Lowest	54.1600	39.2133	6.7333	1.9533	1.2133	84.9333	73.4000	1.5300	48.5133	6.1333
	Range Highest	63.5867	51.4467	8.8000	2.2733	1.4533	134.0000	106.5333	2.4000	63.8500	8.3333

Table 2: Coefficient of variations, genetic variability heritability, genetic advance and genetic advance as percent of mean for 10 traits in onion genotypes

Character	GV	PV	CV		h2 (bs) (%)	GA		GA as percent on mean	
			GCV	PCV		1%	5%	1%	5%
Plant height	7.46	9.48	4.66	5.25	79	6.40	4.99	10.92	8.52
Leaf height cm	8.48	8.98	6.36	6.54	94	7.48	5.83	16.32	12.74
No. of leaves	0.22	0.38	6.16	8.22	56	0.92	0.72	12.18	9.50
Plant girth cm	0.01	0.02	3.93	5.84	45	0.15	0.12	6.98	5.45
Leaf girth	0.00	0.01	4.32	5.99	52	0.11	0.09	8.24	6.43
Biomass Yield / plant gm	210.54	211.24	13.90	13.92	100	38.24	29.84	36.63	28.58
Bulb weight / plant gm	86.10	95.15	10.25	10.77	90	23.30	18.18	25.73	20.08
Scales / bulb	0.31	0.46	7.87	9.54	68	1.22	0.95	17.16	13.39
Bulb size in diameter / plant mm	10.72	21.03	5.96	8.35	51	6.17	4.82	11.25	8.78
Bulb yield / plot kg	0.08	0.08	14.02	14.13	99	0.72	0.56	36.73	28.66

Table 3: Genotypic correlation coefficient for 10 characters for onion genotypes

No	Character	Plant height cm	Leaf height cm	No. of Leaves	Plant girth cm	Leaf girth cm	Biomass yield/ Plant gm	Bulb weight/ Plant gm	Scales/ Bulb	Bulb size in Diameter/ Plant mm	Bulb yield/ Plot kg
1	Plant height cm	1.0000	0.9899 **	0.7060 *	0.9955 **	0.8649 **	0.9224 **	0.8788 **	0.9369 **	0.8041 **	0.9289 **
2	Leaf height cm		1.0000	0.5830 *	0.7760 *	0.6811 *	0.9323 **	0.9609 **	0.8123 **	0.8410 **	0.9325 **
3	No. of Leaves			1.0000	0.7323 *	0.8568 **	0.6999 *	0.5668 *	.7518 *	0.7739 *	0.6046 *
4	Plant girth cm				1.0000	0.8886 **	0.9137 **	0.9478 **	0.6706 *	0.9024 **	0.7954 *
5	Leaf girth cm					1.0000	0.8793 **	0.7790 *	0.7582 *	0.8643 **	0.8574 **
6	Biomass yield/ Plant gm						1.0000	0.9477 **	0.9712 **	0.9046 **	0.9761 **
7	Bulb weight/ Plant gm							1.0000	0.9947 **	0.9896 **	0.9934 **
8	Scales/ Bulb								1.0000	0.9745	0.8232

										**	**
9	Bulb size in Diameter/ Plant mm									1.0000	0.8261 **
10	Bulb yield/ Plot kg										1.0000

* and ** indicate significant at 5% and 1% level, respectively.

Table 4: Phenotypic correlation coefficient for 10 characters for onion genotypes

No	Character	Plant height cm	Leaf height cm	No. of Leaves	Plant girth cm	Leaf girth cm	Biomass yield/ Plant gm	Bulb weight/ Plant gm	Scales/ Bulb	Bulb size in Diameter/ Plant mm	Bulb yield/ Plot kg
1.	Plant height cm	1.0000	0.8513 **	0.4995 **	0.7021 **	0.5954 **	0.9013 **	0.8354 **	0.8156 **	0.7820 **	0.8983 **
2.	Leaf height cm		1.0000	0.4416 *	0.7335 **	0.4151 *	0.9036 **	0.8954 **	0.7909 **	0.7658 **	0.9132 **
3.	No. of Leaves			1.0000	0.4124 *	0.4752 *	0.5163 **	0.4474 *	0.4456 *	0.5367 **	0.4553 *
4.	Plant girth cm				1.0000	0.5115 **	0.7298 **	0.8088 **	0.5580 **	0.6496 **	0.7882 **
5.	Leaf girth cm					1.0000	0.6416 **	0.5540 **	0.5528 **	0.4838 *	0.5874 **
6.	Biomass yield/ Plant gm						1.0000	0.8968 **	0.8283 **	0.7774 **	0.9670 **
7.	Bulb weight/ Plant gm							1.0000	0.7424 **	0.7537 **	0.9347 **
8.	Scales per bulb								1.0000	0.7548 **	0.8119 **
9.	Bulb size in Diameter/ Plant mm									1.0000	0.7484 **
10.	Bulb yield per plot kg										1.0000

* and ** indicate significant at 5% and 1% level, respectively.

Conclusion

On the basis of performance of 14 genotypes of onion (*Allium cepa*.) AFDR genotype was found superior in terms plant height (63.58cm), leaf height (51.44cm), number of leaves (8.80), plant girth (2.27cm), leaf girth (1.45cm), biomass yield per plant (134.00gm), bulb weight per plant (106.53gm), bulb yield per plot (2.40kg), bulb size in diameter (63.85mm), number of scales (8.33) per hectare followed by N-53. Larger amount of variability was exhibited in the genotypes for selection. The traits like biomass yield per plant, bulb weight per plant, bulb yield per plot were found high heritability coupled with high genetic advance as percent of mean providing good scope for further improvement in advance generation. The high value of genotypic coefficient of variation (14.02) and where as phenotypic coefficient of variation (14.13) was exhibited for bulb yield per plot (kg). Heritability in broad sense was high for all the traits plant height, leave height, biomass yield per plot, bulb weight, scales per bulb, bulb yield per plot and medium for traits number of leaves, plant girth, leaf girth and bulb size in diameter. Genetic advance was high for biomass yield per plot and medium for bulb weight.

References

1. Al-Jibourie HA, Miller PA, Robinson HV. Genotype and enviormental variances and co-variances in addition to upland cotton cross of interspecific origin. Agron. J 1958;50:533-536.
2. Ananthan M. Genetic variability, correlation and path analysis in onion (*Allium cepa* var. cepa L.) genotypes for storage losses. Progressive Agriculture 2010;10(2):260-264.
3. Ananthan M, Balakrishnamoorthy G. Genetic variability and path analysis in bellary onion (*Allium cepa* var. *cepa* L.) for storage losses. Madras Agri. J. 2007;94(7/12):147-150.
4. Burton GW, Devane EM. Estimating eritability in tall fescue (Festuca arunidinacea) from replicated clonal material. Argon. J. 1953;45:478-481.
5. Dhotre M, Allolli TB, Athani SI, Halemani LC. Genetic variability, character association and path analysis studies in Kharif onion (*Allium cepa* var. cepa L.). Asian J of Horti 2010;5(1):143-146.
6. Golani IJ, Vaddoria MA, Mehta DR, Naliyadhara MV, Dobariya KL. Analysis of yield components in onion Indian J Agric. Res. 2006;40(3):224-227.
7. Gowda RV, Singh TH, Somkuwar RG. Genetic variability in onion (*Allium cepa.* L.). PKV Res. J 1998;22(1):146-148. 5.
8. Gurjar RSS, Singhania DL. Genetic variability, correlation and path analysis of yield and yield components in onion. Indian J of Horti 2006;63(1):53-58. 23.
9. Haydar A, Sharker N, Ahmed MB, Hannan MM, Razvy MA, Hossain M, *et al*. Genetic Variability and Interrelationship in Onion (*Allium cepa* L.) Middle-East. J of Sci. Res. 2007;2(3-4):132-134.
10. Hosamani RM, Patil BC, Ajjappalavara PS. Genetic variability and character association studies in onion (*Allium cepa* L.). Karnataka J of Agri. Sci. 2010;23(2):302-305.
11. Johnson HW, Robison HF, Comstock RE. Estimation of genetic and enviourmental variability in soyabean, Argon. J. 1955;47:477-483
12. Mohanty BK. Genetic variability, correlation and path analysis in onion seed crop. Indian J of Horti 2000;57(4):329-333.

13. Mohanty BK. Studies on genetic variability, character association and path coefficients in kharif onion. *Pro. Horti* 2002;34(1):60-64.
14. Mohanty BK. Studies on variability, heritability, character association and path coefficients in kharif onion. Horti. J 2002;15(1):97-104.
15. Mohanty BK. Variability, heritability and path coefficient studies in onion (*Allium cepa* L.) seed crop. Haryana J of Horti. Sci. 2002;31(3/4):241-244.
16. Mohanty BK, Prusti AM. Studies on variability, heritability, correlation and path coefficients in kharif onion. Orissa J of Horti. 2001;29(2):75-78.
17. Mohanty BK. Genetic variability, inter-relationship and path analysis I onion. J Trop. Agric. 2001;39:17-20.
18. Navaldey Bharti Ram, R. B. Meena, M. L. Yogita (2011) Genetic variability studies in onion (*Allium cepa* L.). *Ann. of Horti.* 4: 2, 171-175.
19. Panse VG, Sukhatme PV. The application of genetics to plant breeding inheritance of quantitative characters and plant breeding. J Genet 1957;40:283-302.
20. Rajalingam GV, Haripriya K. Genetic variability in onion. Madras Agri. J 1998;85(5/6):248-250.
21. Singh RK, Bhonde SR, Gupta RP. Genetic variability in late *kharif* (*Rangada*) onion (*Allium cepa* L.). J App. Horti. (Lucknow); 2011;13(1):74-78.
22. Singh RK, Dubey BK, Bhonde SR, Gupta RP. Estimates of genetic variability and correlation in red onion (*Allium cepa*) advance lines. Indian J of Agri. Sci. 2010;80(2):160-163.
23. Wlkley A, Black AI. Analysis of organic carbon. Soil. Sc 1971;63:251.
24. Wright. Mechanical analysis of soil by Pipetter method J Soil and Crop 1939;8(2):98-99.