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THE ROLE OF FRACTIONATION ADDING DIFFERENT LEVELS OF PHOSPHATE FERTILIZER (DAP) IN THE PROPERTIES OF GROWTH AND PRODUCTIVITY OF BARLEY CROP *HORDEUM VULGARE* L.

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Abstract:

The field experiment was conducted during the winter season 2020-2021 at Al-Hartha Research Station of the College of Agriculture, University of Basra. To study the effect of phosphate fertilizer levels (P0, P1, P2, P3) kg P ha^{-1}, added in the form of Diammonium Phosphate (DAP) fertilizer and three times for adding; once when planting (m1), the second two batches, 0.5 quantity at planting and 0.5 after a month from germination (m2), and third 0.33 quantity at planting and 0.33 after a month from the germination and 0.33 in the spike stage (m3) on the growth and yield of barley Hordeum Vulgar L. The study was carried out as a factorial experiment using a randomized complete block design (R.C.B.D) with three replicates, the area of the experimental unit is 3 * 3 m^2. The plant samples were collected during four stages of plant growth, which included tillering (S1), elongation (S2), spike (S3), and full maturity (S4). The plant samples were dried at 65° C until the weight was stable and their dry weight was recorded. The plant samples were ground, and the phosphorus concentration absorbed phosphorus and recovered phosphorous were estimated. The weight of 1000 grains, grain yield, and biological yield at harvest was measured. The results showed that the level (P3) was superior by giving the highest average of dry weight, absorbed phosphorous, weight of 1000 grains, grain yield, and biological yield. The results also showed the superiority of the date of addition in three batches (m3) by giving the highest average of dry weight, absorbed phosphorous, weight of 1000 grains, grain yield, and biological yield. As for the effect of interactions between levels and dates of addition, the level achieved 90 kg P ha^{-1}(P3) with the addition in three batches (m3) by giving the highest grain yield, biological yield, weight of 1000 grains, dry weight and uptake phosphorous. As for the triple interaction between growth stages, phosphorous levels, and dates of addition, the level (P3) for the elongation and addition stage was given in three batches, the highest dry weight and absorbed phosphorous.

Keywords: Hordeum vulgare L.; phosphate fertilizer (DAP); productivity of barley crop; fractionation

INTRODUCTION

The barley crop *Hordeum vulgare* L. It is one of the crops of the Gramineae family; it is the fourth of the strategic grain crops after wheat, rice, and yellow corn. In Iraq, this crop comes after wheat in cultivated areas and production (Jabr, 1997). The Central Bureau of Statistics announced, the barley production was estimated at 1756 thousand tons for the winter season of 2020 for the barley crop. Barley tolerates drought and salinity and is highly efficient in water consumption so that it can be grown in the rainy and irrigated areas in Iraq. It is resistant to the difficult growing conditions in the dry and semi-arid regions from the cold" Drought, basal, salinity, resistant to bushes and competitor to weeds, due to its rapid growth and faster maturation than wheat (Grando, 2002). The economic importance of barley crop is concentrated in its use as a feed material given to animals in grain, hay, or green fodder materials. It may be mixed with leguminous crops to improve the quality of forage. It is mixed with wheat for the manufacture of bread. It is also used in the manufacture of alcoholic beverages, vinegar, yeast, and medicine as a laxative, soothing, and anti-aging because it contains vitamins A and E.

Phosphorous is one of the basic elements of the plant and is involved in the synthesis of nucleic acids and enzymes necessary for energy reactions and the synthesis of energy compounds ADP, ATP, and the companion enzymes NADP, NAD. It is also included in the composition of phospholipids, which, together with protein, are an essential part of cell membranes (Mengel and Kirkby, 1987). Phosphorus added to soil, especially lime, is subjected to a series of reactions that transform it into forms that are not ready for absorption by the plant after a short period of adding it to the soil as a result of its interaction with calcium carbonate (Ali *et al.,* 2014). As a result of these interactions, phosphorus use efficiency decreases to 25-30%. Bruulsema *et al.,* (2013) indicated that good management to increase the efficiency of phosphate fertilizers depends on the fertilizer source, the date of application, and the method of application. And Mallarino *et al.,* (2005) showed that the plant's uptake of phosphorous depends on several factors, including the amount of added phosphorous and the ability of the soil to fix phosphorous. The results of the studies of Dasher (2000) and Al-Abdullah (2015) on wheat and Bahadli (2021) on corn plants showed that the amount of phosphorous absorbed during the vegetative growth stage is about 50% of the total amount absorbed during the growing season. Bruulsema *et al.,* (2013) showed that more than half of the total phosphorous absorbed in maize plants occurred after the flowering stage, while most of the nitrogen and potassium were absorbed during the vegetative growth period (before flowering).

The sources indicate that up to 50% of the total phosphorous absorbed in plants at the end of the growing season is at advanced stages of plant growth and after a relatively long period of adding phosphate fertilizer to the soil from the beginning of the growing season, the time when the added phosphorus turns into unformed forms ready and to ensure that plants are supplied with sufficient amounts of phosphorous during the advanced stages of growth, dividing the amount of fertilizer into doses added during the growing season may be a successful alternative to the method of adding phosphate fertilizer all at once at the beginning of the growing season. In the absence of previous studies on the effect of dividing the phosphate fertilizer dose into batches during the growing season instead of one batch from the beginning of the growing season on the growth and productivity of the barley crop, this study was proposed to show the effect of the times of adding different levels of phosphorous during the growing season on the growth and yield of barley plant.

MATERIALS AND METHODS

The study was carried out at Al-Hartha Research Station of the College of Agriculture, University of Basra, during the winter growing season 2020-2021. Field soil samples were collected at a 0-30 cm depth before planting. They were dried, ground, and passed through a 2-mm sieve to perform the analyzes for the chemical and physical properties shown in Table (1). The study included the addition of phosphorous at levels (0, 30, 60, 90) kg ha^{-1} in the form of diammonium phosphate (DAP) and three times that included the whole amount at planting (m1) and 0.5 the amount at planting, and 0.5 after a month from germination (m2) and 0.33 the amount at planting, 0.33 after a month of germination, and 0.33 at the spike stage (m3). The seeds of the barley crop, Ibaa 99 cultivar, were sown on 16.11.2020 in lines inside panels with dimensions of 3 * 3 m^2 and at a rate of 120 kg ha^{-1}.

Urea fertilizer was added to all treatments at 120 kg ha^{-1} and potassium fertilizer in potassium sulfate at 120 kg ha^{-1}. The fertilizers were added in two batches, the first after a week of planting and the second after a month of germination Al-Abdullah (2015). DAP fertilizer was added as a source of phosphorous at the levels and dates of addition indicated above. Plant samples were randomly collected from all treatments at tillering (S1), elongation (S2), spike (S3), and full maturity (S4) stages. The samples were dried after cleaning at 65℃ until the dry weight was stable. The samples were ground using an electric grinder, and 0.2 g of the dry ground matter was digested using a mixture of sulfuric acid 96% and perchloric acid 4%, according to the method of Cresser and Parson (1979). The phosphorous was estimated in the digestion solution using a spectrophotometer according to Sommer and Nelssom (1972). The amount of phosphorous absorbed in the plant was calculated according to the law: -

The efficiency of fertilizer use was calculated based on absorbed phosphorous according to the method (Yaduvanshiki *et al.,* 1984) and according to the following equation: -

Fertilizer use efficiency = Amount of phosphorous in the fertilizing treatment - the amount of phosphorous in the control treatment / the amount of added phosphorous
Absorbed phosphorous = phosphorous concentration in the plant * dry weight.

Table (1) some physical and chemical properties of field soil before planting

Adjective	value		Unit
PH	7.4		
EC	8.0		Ds m^{-1}
ready- nitrogen	37.00		mg kg $soil^{-1}$
ready- phosphorous	12.75		
Soil Separators	sand	70	mg kg $soil^{-1}$
	silt	590	
	clay	340	

Dissolved positive ions	Ca^{++}	2.4	Mm l^{-1}
	Mg^{++}	1.2	
	Na^{+}	1.2	
	K^{+}	0.3	
Dissolved negative ions	Cl^{-}	2.7	
	$SO_4^{=}$	2.54	
	HCO_3^{-}	0.4	
soil texture		Silty clay loam	

The plants were harvested after the full maturity stage by harvesting the middle lines of the grass square (1 m^2) and converted to 1 t ha^{-1}. After the spikes were neglected from the harvested area, 1000 grains were randomly taken from each experimental unit and weighed using a sensitive scale. The study was carried out as a factorial experiment with completely randomized sectors (R.C.B.D) with three replications so that the number of experimental units was 4 * 3 * 3 = 36 experimental units. The data were statistically analyzed using the statistical analysis program SPSS (Version 23), and the averages were compared using the least significant difference test (LSD) at the level of 5% probability (Al-Rawi and Khalaf Allah, 1980).

RESULTS AND DISCUSSION

1- Dry weigh

The results of Table (2) showed significant differences in the levels of phosphorous added in dry weight, as the level achieved 90 kg ha^{-1} averaged 2848.46 kg ha^{-1}, with an increase of 30.54% compared to the control treatment, which recorded an average of 2182.08 kg ha^{-1}, and recorded levels 30 and 60 kg ha^{-1} averaged 2370.65 and 2,655.54 kg ha^{-1}, with an increase of 8.64 and 21.69% with the comparison treatment, respectively. The reason was attributed to the increase in the level of phosphate fertilizer from 0 to 90 kg ha^{-1}, which led to an increase in the availability of phosphorous to plants; thus, an increase in the amount of plant material manufactured, and the results agreed with Singh (2020) and Al-Lami and Mansour (2015).

The times of addition also indicate that the addition in three batches had a higher average dry weight of 2563.34 kg ha^{-1} compared to the treatment of one-time addition and two-batch addition, which recorded an average of 2457.52 and 2511.70 kg ha^{-1}, respectively, as the addition of phosphorous on different dates contributed to Increasing the availability of phosphorous for plants. Phosphorous has an important role in increasing the root system and thus increasing absorption, leading to the formation of a large vegetative group and thus increasing dry weight.

Table (1) Effect of adding phosphorous levels, times of addition, and growth stages on the dry weight of barley plant (kg ha^{-1})

Adding times	**growing stages**	**Phosphorous levels kg P** ha^{-1}				**interaction S*m**
		P0	**P1**	**P2**	**P3**	
m_1	**S_1**	116.75	137.94	156.28	192.57	**150.88**
	S_2	490.68	561.45	738.82	801.04	**648.00**
	S_3	2747.72	2826.40	2955.13	3129.63	**2914.72**
	S_4	5302.58	5767.11	6643.22	6912.94	**6156.46**
m_2	**S_1**	121.89	147.73	166.82	221.07	**164.37**
	S_2	502.84	683.91	768.65	845.60	**700.25**
	S_3	2793.91	2872.22	2986.97	3171.30	**2956.10**
	S_4	5307.06	5799.50	6710.57	7087.12	**6226.06**
m_3	**S_1**	123.88	148.20	183.92	255.74	**177.94**
	S_2	510.82	723.24	783.09	968.91	**746.51**
	S_3	2809.00	2917.34	3017.43	3287.18	**3007.73**
	S_4	5357.88	5862.71	6755.66	7308.47	**6321.18**
Phosphorous averages		**2182.08**	**2370.65**	**2655.54**	**2848.46**	_____
P*S		**P0**	**P1**	**P2**	**P3**	**average growth stages**
S_1		120.84	144.62	169.01	223.12	**164.40**
S_2		501.44	656.20	763.52	871.85	**698.25**
S_3		2783.54	2872.00	2986.51	3196.04	**2959.52**
S_4		5322.51	5809.77	6703.15	7102.84	**6234.57**
P*m		**P0**	**P1**	**P2**	**P3**	**Average Additiontimes**
m_1		2164.43	2323.22	2623.36	2759.05	**2457.52**
m_2		2181.42	2375.84	2658.25	2831.27	**2511.70**
m_3		2200.39	2412.87	2685.02	2955.07	**2563.34**
LSD < 0.05		**P=5.04**		**m=4.37**		**S=5.04**
P*m=8.74		**S*m=8.74**		**P*S=10.09**		**P*S*m=17.48**

The results also showed significant differences for the four stages of growth; as achieved in the stage of full maturity, the highest average dry weight amounted to 6234.57 kg ha^{-1}, while the rest of the treatments (tillering, elongation and spike) recorded averages of 164.40, 698.25 and 2959.52 kg ha^{-1}, respectively. The results of Table (2) for the interaction between levels, dates of addition, and stages of growth showed significant differences in dry weight in plants, as the treatment achieved 90 kg ha-1 and the addition in three batches to the stage of full maturity reached the highest dry weight of 7308.47 kg ha^{-1} at that time the comparison treatment was recorded. The blistering stage was less Dry weight of 116.75 kg ha^{-1}.

2- Absorbed phosphorous:

The results of Table (3) showed significant differences in the levels of added phosphorous, as the level achieved 90 kg ha^{-1}, an average absorbed amount of 7.90 kg ha^{-1}, compared to the control treatment, which recorded an average of 2.71 kg ha^{-1}, and the two levels recorded 30 and 60 kg ha-1 the average amount was 4.38 and 6.21 kg ha^{-1}, with an increase of 61.62 and 129.15%, with the control treatment, respectively. The reason is attributed to the increase in the level of phosphate fertilizer from 0 to 90 kg ha^{-1}, which led to an increase in the availability of phosphorus for plants. These results agreed with Al-Zubaidi (2006) and Al Hilfi (2015). The results of Table (3) showed significant differences for the time of addition, as the addition of three batches achieved the highest average of absorbed phosphorous, which amounted to 5.84 kg ha-1, with a significant difference from the treatment of one-time addition and addition in two batches, which recorded an average of 4.77 and 5.29 kg ha^{-1}, respectively. The reason is that adding phosphorous in three batches reduces the risk of phosphorous stabilization and increases its readiness. The results of Table (3) of the interaction between levels, dates of addition, and stages indicate significant differences in the concentration of phosphorous in the plant, as the treatment achieved 90 kg ha^{-1} and the addition in three batches to the stage of full maturity achieved the highest amount of phosphorous absorbed amounted to 20.49 kg ha^{-1} at that time the comparison treatment and batch were recorded for the tillering stage, the lowest amount of uptake was 0.12 kg ha^{-1}.

Table (3) Effect of adding phosphorous levels, times of addition, and stages of growth on phosphorus Uptake (kg ha^{-1}) of barley

Adding times	**growing stages**	**Phosphorous levels kg P** ha^{-1}				**interaction S*m**
		P0	**P1**	**P2**	**P3**	
m_1	**S_1**	0.12	0.18	0.31	0.48	**0.28**
	S_2	0.86	1.15	1.87	2.55	**1.61**
	S_3	3.77	5.30	6.70	8.22	**6.00**
	S_4	5.64	8.65	14.26	16.25	**11.20**
m_2	**S_1**	0.14	0.22	0.39	0.58	**0.33**
	S_2	0.94	1.49	2.01	3.06	**1.88**
	S_3	3.80	5.94	7.17	9.94	**6.71**
	S_4	5.93	9.76	15.12	18.10	**12.23**
m_3	**S_1**	0.14	0.27	0.46	0.73	**0.40**
	S_2	1.00	1.80	2.22	3.83	**2.21**
	S_3	3.87	6.34	7.74	10.61	**7.14**
	S_4	6.32	11.41	16.26	20.49	**13.62**
Phosphorous averages		**2.71**	**4.38**	**6.21**	**7.90**	———
P*S		**P0**	**P1**	**P2**	**P3**	**average growth stages**
S_1		0.13	0.22	0.39	0.60	**0.33**
S_2		0.93	1.48	2.03	3.15	**1.90**
S_3		3.81	5.86	7.20	9.60	**6.62**
S_4		5.96	9.94	15.21	18.30	**12.35**
P*m		**P0**	**P1**	**P2**	**P3**	**Average Addition times**
m_1		2.60	3.82	5.79	6.87	**4.77**
m_2		2.70	4.35	6.17	7.92	**5.29**
m_3		2.83	4.96	6.67	8.91	**5.84**
L.S.D < 0.05		**P=0.141**		**m=0.122**		**S=0.141**
P*m=0.245		**P*S=0.283**		**S*m=0.245**		**P*S*m=0.491**

3- Recovered phosphorous:

The results in Table (4) showed that the level of 60 kg P ha^{-1} was superior. It recorded the highest average of 15.42%, superior to the rest of the added levels (30 and 90), which recorded 13.40 and 13.69%, respectively. A reason may be attributed to Increasing the amount of absorption in phosphorous to the stage of full maturity, and these results agreed with Al-Jumaili (2016) and Al-Zubaidi (2006).

There were significant differences in the times of addition. The addition in three batches achieved the highest average of 16.42%, with a significant difference between the treatment of adding in one batch and adding in two batches, which recorded an average of 12.21 and 13.88%, respectively.

The results of Table (4) showed no significant differences in the interaction of levels with the times of addition.

Table (4) Effect of phosphorous levels and times of addition to the stage of full maturity and the interaction between them in the amount of phosphorous recovered (efficiency of fertilizer use %)

Levels (P)	**Adding times (m)**			**Average (p)**
	One batch	two batches	three batches	
30	10.46	12.80	16.96	13.40
60	14.37	15.33	16.56	15.42
90	11.79	13.53	15.74	13.69
Average (m)	12.21	13.88	16.42	_____
L.S.D < 0.05	**P=1.38**	**m=1.20**		**P*m= n.s**

4- Weight of 1000 grains:

The results of Table (5) indicate that the 90 kg P ha^{-1} recorded the highest average of 35.11 g, with an increase of 35.04% over the control treatment, which recorded the lowest average of 26.00 g. Photosynthesis thus transports manufactured materials to their storage places (grains), and this is consistent with Al-Jumaili (2016) and Al-Hassoun (2010). The results in Table (5) show that the treatment of addition times with three batches is superior to the other two treatments, as it recorded the highest average of 32.48 g, due to the increase in phosphorous concentrations in the advanced stages of growth and the increase in uptake by the plant. Which indicated that there were no significant differences for the date of addition. As for the interaction, the level of the fertilizer exceeded 90 kg P ha^{-1} with the additional treatment in three batches recording the highest weight of 1000 grains that reached 37.57 g, while the comparison treatment with all addition treatments recorded the lowest values for this trait.

Table (5) Effect of phosphorous levels and times of addition to the stage of full maturity and the interaction between them in weight of 1000 grains (g)

Levels (P)	**Adding times (m)**			**Average (p)**
	One batch	two batches	three batches	
0	24.20	26.27	27.20	**26.00**
30	28.37	30.33	30.20	**29.63**
60	29.80	29.93	34.60	**31.44**
90	33.20	34.57	37.57	**35.11**
Average (m)	**28.89**	**30.27**	**32.48**	_____
L.S.D < 0.05	**P=1.60**	**m=1.38**		**P*m=2.77**

5- Grain yield:

The results in Table (6) show that the level of 90 kg P ha^{-1} recorded the highest average grain yield of 3.344 tons ha^{-1}, superior to the rest of the added levels (P0, P1, P2), which recorded an average grain yield of 1.781, 2.534, 2.986 tons ha^{-1}, respectively. The reason for the increase in yield may be attributed to the increase in phosphorous levels, which leads to an increase in the content of nitrogen, phosphorous, and potassium elements in the plant, and by increasing their availability and absorption, they have an important role in the activity of vital processes and increase the yield. These results agree with the findings of Sighn *et al.,* (2020).

The results of Table (6) indicate the superiority of the m3 treatment (added with three batches) in recording the highest average grain yield of 2.738 t ha^{-1}, superior to the other two treatments, m1 (one batch) and m2 (two batches), which recorded an average of 2.538 and 2.708 t ha^{-1} on straight. The combination of 90 kg P ha^{-1} with the addiction treatment (m3) achieved the highest grain yield of 3.531 t ha^{-1}, while the comparison treatment with the one-time addition treatment (m1) recorded the lowest grain yield of 1.750 t ha^{-1}.

Table (6) Effect of phosphorous levels and times of addition to the stage of full maturity and the interaction between them in grain yield (t ha^{-1})

Levels (P)	**Adding times (m)**			**Average (p)**
	One batch	two batches	three batches	
0	1.750	1.801	1.791	**1.781**
30	2.369	2.716	2.517	**2.534**
60	2.825	3.022	3.112	**2.986**
90	3.207	3.293	3.531	**3.344**
Average (m)	**2.538**	**2.708**	**2.738**	_____

L.S.D < 0.05	P=0.044	m=0.038	P*m= 0.076

REFERENCES

1. Al-Abdullah, S. A. M. 2015. Effect of adding nitrogen on the absorption of N, P, and K and their distribution in plant parts and the growth and yield of three cultivars of wheat *Triticum aestivum* L. Ph.D. thesis - College of Agriculture - Department of Field Crops - University of Basra.
2. Al-Absawy, M.u H. M. 2018. Effect of adding different levels and batches of phosphate fertilizer on the kinetics and release of phosphorous in the soil and the growth and yield of two wheat cultivars *Triticum aestivum* L. Master's thesis. Soil and Water Resources Sciences - College of Agriculture - Al-Muthanna University.
3. Al-Bahadli, A. H. J. 2021. Effect of levels and depths of phosphorous addition mixed with the plowing layer of the soil on the growth and yield of yellow corn (*Zea mays* L.) Master's thesis. Field crops, College of Agriculture, University of Basra.
4. Al-Hassoun, S. N. 2010. Effect of sulfur, magnesium, and phosphate rock levels on phosphorous release and wheat crop growth. Master Thesis. Faculty of Agriculture. Baghdad University.
5. Al-Helfi, S. K. J. 2015. Effect of different levels of phosphate fertilizer on the growth and yield of three cultivars of wheat, *Triticum aestivum* L. Master's thesis - College of Agriculture, University of Basra.
6. Ali, N. S., Hamdallah, S. R., and Abdel-Wahhab, A. S. 2014. Soil Fertility. Ministry of Higher Education and Scientific Research. Faculty of Agriculture. Baghdad University.
7. Al-Jumaily, M. O. S. 2016. Effect of humic acid addition method and phosphorous level on some growth and yield of barley (*Hordeum vulgare* L.). Diyala Journal of Agricultural Sciences, 8(1): 92-104.
8. Al-Lami, A. J.,and Muntazer, H. M. 2015. Effect of phosphate, organic, and biofertilizers on phosphorous uptake and maize yield. The Iraqi Journal of Soil Sciences Volume 15 (1): 142-154.
9. Al-Rawi, K. M., and Muhammad, A. K. 1980. Design and analysis of agricultural experiments. College of Agriculture and Forestry, University of Mosul.
10. Al-Zubaidi, R. A. O. 2006. Effect of soil moisture, level, and method of phosphorous addition on some soil properties, growth, and productivity of barley. Master's Thesis - College of Agriculture - University of Basra.
11. -Bruulsema, Tom W., G. Philip Robertson, Ron J. Gehl, David Kanter, Denise L. Mauzerall, C. Alan Rotz, Candiss O. Williams. 2013. Nitrogen–climate interactions in US agriculture. Biogeochemistry, springer. vol114:41–70.
12. Bruulsema, Tom W., G. Philip Robertson, Ron J. Gehl, David Kanter, Denise L. Mauzerall, C. Alan Rotz, Candiss O. Williams. 2013. Nitrogen–climate interactions in US agriculture. Biogeochemistry, springer. vol114:41–70.
13. -Cresser, M.E. and Parsons, G.W. 1979. Sulphuric, perchloric, and digestion of plant material for determination of Nitrogen, phosphorus, potassium, Calcium, and Magnesium, analytical chemical. Acta. 109: 431-436.
14. -Cresser, M.E. and Parsons, G.W. 1979. Sulphuric, perchloric, and digestion of plant material for determination of Nitrogen, phosphorus, potassium, Calcium, and Magnesium, analytical chemical. Acta. 109: 431-436.
15. Desher, M. A. 2000. Response of tomato plants to superphosphate fertilizer added with drip irrigation water grown in desert soils: Master's thesis, College of Agriculture, University of Basra.
16. Gabr, A. S. 1997. The kinetics in describing the liberation and availability of phosphorous from phosphate gypsum in calcareous soil. Iraqi Journal of Agricultural Sciences. Volume 33(3): 9-16.
17. -Mengel and Kirkby. 1987. Principles of plant nutrition. Int. Potash Inst., Bern, Switzerland.
18. -Singh, Ratan, M Devender Reddy, Girish Pandey, and Anuj Kumar. 2020. Effect of different phosphorus levels on barley performance (*Hordeum vulgare* L.). Journal of Pharmacognosy and Phytochemistry, vol 9(2):363-366.
19. -Sommers, L. E., and D. W. Nelson. 1972. Determination of total phosphorus in soil: A rapid perchloric acid digestion procedure. Soil Sci. Soc. Am. J. 36: 902 – 204.
20. -Yaduvanshi, H.S. 1984. J.Indian .soc soil sci. 32: 97. C.F bartas, M.L .and chandhry, M.L. Indian soi soc. Soil sci. 36:714-718.