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# Potassium (K) Availability in Agricultural Soil and Role of Fertilizer: A Case Study of Sarenga Block, Bankura District, West Bengal

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**Abstract**

Potassium *(K)* is an essential plant nutrient, has a major role in crop production. *K* is the most abundant mineral in earth surface (1.9% of the earth crust) but plants can uptake *K+* mainly from solution and slightly from exchangeable *K*. For this reason *K* deficiency is observed in different locations. This availability of Potassium *(K)* in soil mostly depends on some factors like parent material of the soil, intensity of weathering, soil pH, amount of organic matter, amount of precipitation and porosity of soil etc. In agricultural soil availability of *K* mostly depends on *K* fertilizer usage. In this paper correlation technique is used to establish the relationship of different variables (soil pH, Organic Matter, Texture, *K* Fertilizer usage and Cropping Intensity) with availability of *K* in form of $K_2O$ through a case study of Sarenga Block, Bankura District, West Bengal. 166 samples from each and every mouza of the Block and 17 samples (10%) from higher group and 17 (10%) samples from lower group in respect of $K_2O$ availability have been chosen for the analysis. Result shows that there is a strong positive relationship with availability of $K_2O$ with *K* fertilizer usage and cropping intensity. The results are 0.973 and 0.812. Other relationships are very feeble, proves the fact that availability of *K* in the agricultural soil mainly depends on anthropogenic influence.

This paper is divided into two sections. The first section deals with the introduction of the study area and adopted methodology. Section two tries to identify the influence of different factors on availability of Potassium and available Potassium in the form of $K_2O$ in the study area. The paper ends with a conclusion.

**Keywords:** Potassium (K), Cropping Intensity (C.I), Fertilizer, Organic Carbon (O.C), Soil pH, Correlation (r).

**Introduction**

Potassium *(K)* is an essential plant nutrient, has a major role in crop production. *K* has a role in large number of enzymatically catalyzed reactions. *K* is involved in water relations, changes balance and osmic pressure in cells. *K* is important for many crop quality characteristics due to its movement in synthesis and transport of photosynthates to plants reproductive and storage organs like grains, fruits, tubers etc. and subsequent conversion into carbohydrates, proteins, oils, and other products. *K* is essential to photosynthesis through several functions such as ATP synthesis, production and activity of photosynthetic enzymes like RuBP carboylase, $CO_2$ absorption through leaf stomatas and maintenance of electoneutrality during photophosphorylation in chloroplasts. Straw strength also depends on *K.*

*K* exists in soil in structural, non-exchangeable, exchangeable and water soluble forms. However, these forms of *K* are not homogeneously distributed in soils. In general mineral *K* accounts 90% to 98% of total soil *K.* Whereas only 1% to 10% exchangeable and 1% to 2% solution *K* is available in the soil (John L. Havlin et all). Plants can uptake *K+* mainly from solution and slightly from exchangeable *K*. Exchangeable and solution *K* want to maintain an equilibrium within a short time span but non-exchangeable *K* equilibrate very slowly with exchangeable and solution *K.*

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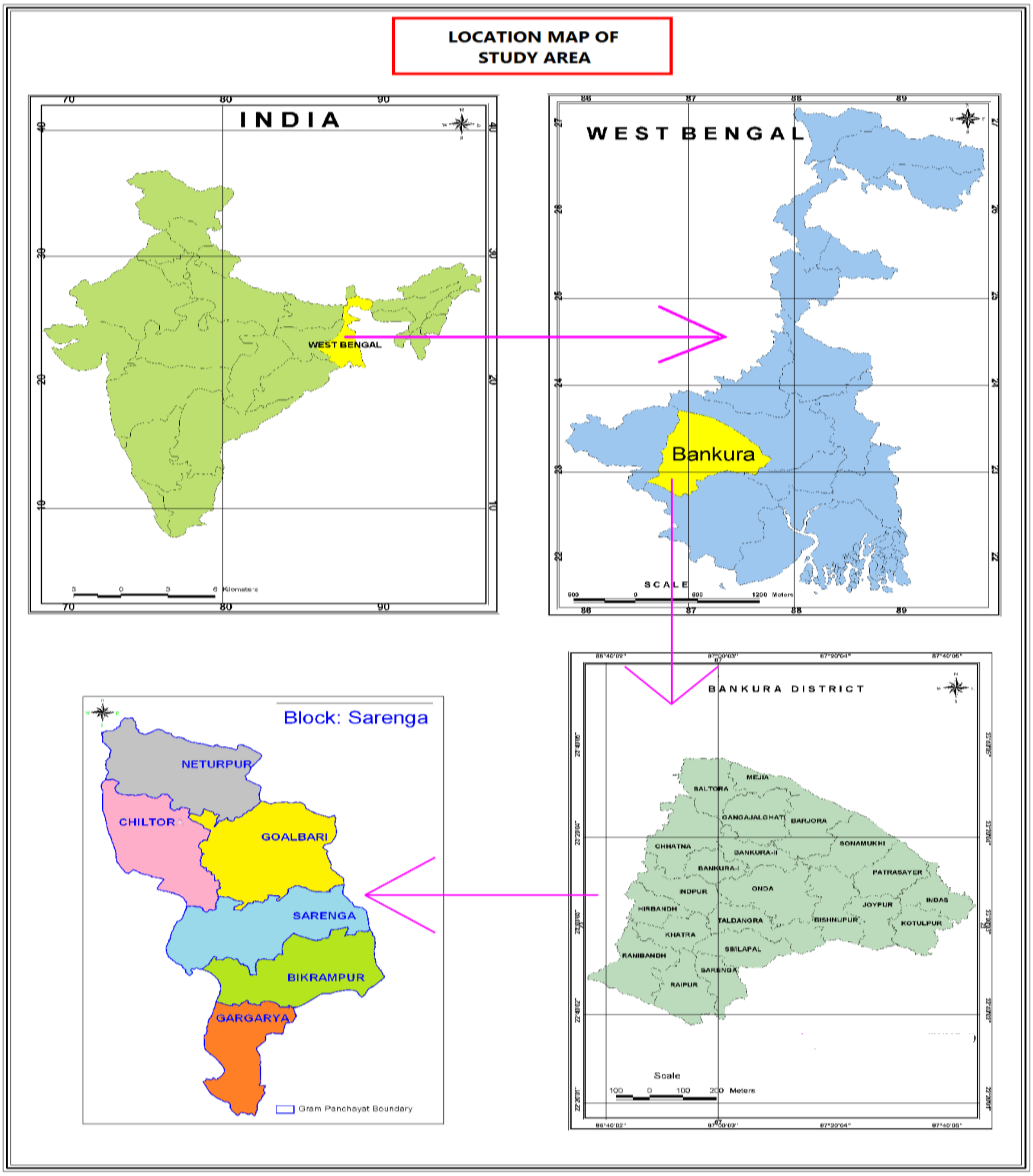
For this reason *K* deficiency is observed in different locations whereas *K* is the most abundant mineral in earth surface (1.9% of the earth crust).

This availability of Potassium *(K)* in soil mostly depends on some factors like parent material of the soil, intensity of weathering, soil pH, amount of organic matter, amount of precipitation and porosity of soil etc. But in agricultural field, it is very difficult to establish a prominent relationship between *K* availability and influences of said factors. In agricultural field every characteristics of soil are directly modified by farming practices and these are not static one, may change even in a same crop season. The study in Sarenga Block, South Bankura, West Bengal tries to identify the influence of Parent material, Soil pH, Organic Matter, Texture, *K* Fertilizer usage and cropping intensity on availability Potassium. And it is tested how much anthropogenic factors manipulate the availability of Phosphorus and what factor is dominating.

This paper is divided into two sections. The first section deals with the introduction of the study area and adopted methodology. Section two tries to identify the influence of different factors on availability of Potassium and available Potassium in the form of $K_2O$ in the study area. The paper ends with a conclusion.

**MAP No-1.**



**Section -1.**

**Location of the Study Area**

Sarenga Block, the region undertaken for the work, is such a region of Bankura District in West Bengal that has been considered as underdeveloped economic zone since long. Sarenga is a part of "Jangal Mahal" (forested part) of West Bengal. Due to remote location, forest as well as agricultural activities, it has a spatial dimension.

The Study area is located in the southern part of Bankura District in West Bengal between the latitude of 22.634˚ North to 22.915˚ North and longitude of 86.913˚ East to 87.105˚ East. It covers an area of 293.51 square Kilometers. Simlapal Block is located in the northern part of Sarenga. Southern and Eastern boundary is formed with Medinipur District. Raipur Block makes its Western boundary. Sarenga is under the Khatra Sub division and this Block has six Gram Panchayats (G.P) namely: Sarenga, Bikrampur, Chiltore, Gargarya, Goalbari and Neturpur. (Map No.-1).

**Important Physical Characteristics of the Study Area**

Soil quality is primarily related with physical earth. Hence, a short description of the physical feature of the study region is essential for understanding the theme.

**Geology**

Regarding geological structure, the study area has three different characteristics. Most of the area is dominated by unconsolidated sand, silt and clay materials. Western margin of the Sarenga is mainly covered with fine and medium sands. Few parts of the region have depicted the character of fragments of pebbles, boulders and gravels. Subsequently, due to weathering, laterite top cover is seen in many parts of the land. Subsurface geological survey reveals that there is a wide cover of boulder and granite bed especially in the northern part of Sarenga. Rest of the area has a thick sequence of sediments and clay.

**Relief**

The elevation of the study region ranges between 60 to 100 meters. Northern parts have a higher elevation which is slightly more than 100 meters. Land elevation gradually decreases to the west and south-west towards the river Kasai. Most of the land of Sarenga lies within the height between 60 to 80 meters. Geographically this region is the outer rim of the Chhoto Nagpur plateau where modification process has been operated during prolonged time.

Western margin of the Block is said to be a part of Kasai river basin. According to NRDMS land classification major part of the Sarenga falls under the category of 'Residual Hillocks'. Western margin, along with the Kasai River, is called 'Flood Plain'. Eastern and Northern part fall under 'Dissected Plateau' category. Some lands under middle portion are called as 'Upper Undulating'.

**Climate**

Climate of the study region represents the typical 'Monsoon' climate. The temperature, rainfall and humidity are quite high and which is favourable for the existing agriculture. The summer temperature, on an average, is up to 40° C and it falls down 10° C during winter months. During the rains temperature shows downward trend. About 85% rain fall occurs during June to September. Total annual rainfall of the region is about 135 cm. In this region there is much significance of rainfall because of the fact that during the rainy season high intensity of agricultural activity is observed. Climate is considered as the most important soil forming factor. In this region, too, it is similarly true. Such hot and humid condition plays an important role in the secondary mineralization and process of lateralization. Due to erosion, transportation and deposition by water soil depth is also affected.

**Methodology**

The entire study is based on primary data except the crop coverage data. The standardized soil samples are collected from each and every mouzas of Sarenga Block after harvesting of Amon paddy in 2014. 166 samples are collected from the field within the depth of 6 inches from the surface. Available $K_2O$ per hectare is estimated to know the amount of available *K* in the soil. After primary processing samples are tested in laboratory in following methods–

**Determination of Available $K_2O$ in Soil**

1. 5 gm. Is taken in a 100 ml conical flask.
2. Then 25 ml ammonium acetate reagent is added.
3. After shaking for five minutes the solution is filtered by Whatman No. 1 filter paper in a funnel top test tube.
4. Meater reading is taken by Flame Photometer.
5. After comparing with standard curve K2O concentration is calculated automatically by micro-processor based flame photometer.

**Preparation of Standard Curve**

1. 5,10,15,20 ppm K2O solutions are prepared from 1000ppm stock solution.
2. After proper calibration of Flame Pohotometer these solution is aspirated in descending order.

**Calculation**

1. Weight of the soil = 5 gm.
2. Volume of ammonium acetate = 25 ml.
3. Concentration of K2O as read from standard curve in ppm. = 'C'
4. Available K2O in soil (ppm or mg/kg.) = C X 5.
5. Available K2O in soil (Kg./Hec.)= C X 5 X 2.24.

**Section – 2**

In this section effort is given to draw out inherent relationship among the soil pH, Percentage of Organic Carbon, Parent material, Potassium (K) fertilizer utilization and cropping pattern. It is well known that availability of $K_2O$ mostly depends on soil pH, Parent material, Percentage of Organic Carbon, Weathering and Precipitation. Out of 166 samples collected from different Mouzas show that there is no any clear cut relationship among the availability of $K_2O$ and others. Parent material varies in south-western Sarenga where it is mainly alluvium, rest of the soil mainly derived from Granite, Gneiss, highly affected by laterization process. Climatic condition is same throughout the study area. So from a careful observation of soil pH, percentage of Organic Carbon, *K* fertilizer usage and cropping pattern may be helpful to estimate the amount of human interference to modify the agricultural soil as well as availability of $K_2O$ in the soil. In this regard 'correlation' statistical technique is used. Correlation values (r) are calculated using the variables of available $K_2O$ and soil pH, available $K_2O$ and percentage of Organic Carbon, available $K_2O$ and K fertilizer usage, available $K_2O$ and cropping intensity.

These correlation values are calculated from all 166 samples. Not only that, out of 166 samples 10% samples (17 samples) are chosen based on lower availability of $K_2O$ and another 10% (17 samples) is chosen where $K_2O$ availability is high.

**Results**

Correlation value (r) shows that there is no relation or feeble negative relationship with the availability $K_2O$ and soil pH. (Table–1). For all samples it is -0.183. These results are -0.064 and -0.176, for 10% samples from lower and higher groups in respect of availability of $K_2O$ in the soil. Observation is also similar in case of availability of $K_2O$ and percentage of organic carbon. Correlation values for all samples, 10 percent from higher group and 10 percent of lower group in terms of availability $K_2O$ are 0.104, 0.069 and -0.334 respectively. So the results do not indicate any specific relationship. On the otherhand high positive correlation values are observed for *K* fertilizer usage and cropping intensity with the available $K_2O$. In case of *K* fertilizer usage for all mouza/samples 'r' value is 0.973. 10 percent samples from both lower and higher groups in terms of availability $K_2O$ have a similar value which are 0.906, 0.910 respectively. Availability of $K_2O$ in soil and cropping intensity are also positively correlated because in general sense more cropping intensity means more fertilizer usage. Results (r) for all mouzas/samples, 10 percent samples from lower and 10 percent from higher groups in terms of availability $K_2O$ are 0.812, 0.877 and 0.814 respectively. These correlation values also indicate that the relationship with cropping intensity and availability of K nutrients is positive but not as high as *K* fertilizer usage values. So a direct and strongly positive relationship is found between *K* fertilizer usage and availability of *K* in the soil. (Table - 2 & 3).

**Table – 1**

**Correlation Values (r) of Different Variables with Availability of $K_2O$ in Soil.**

| Samples | Soil pH and Available $K_2O$ | % of O.C and Available $K_2O$ | C.I and Available $K_2O$ | K Fertilizer and Available $K_2O$ |
|---|---|---|---|---|
| For all Mouzas/ Samples | -0.183 | 0.104 | 0.812 | 0.973 |
| 10% Samples from Lower Group | -0.064 | -0.334 | 0.877 | 0.968 |
| 10% Samples from Lower Group | -0.176 | 0.069 | 0.814 | 0925 |

**Source: Author's Calculation**

**Table- 2**

**Ten (10%) Percent Soil Samples are Chosen where Availability of $K_2O$ is High with other Characteristics of the Samples Year-2014**

| Sl | J.L No. | Mouzas | $K_2O$ Kg. /Hec | pH | % of O.C | Texture | K Fertilizer Used in Amon Paddy. Kg./Hec. | Cropping Intensity (C.I) |
|---|---|---|---|---|---|---|---|---|
| 1 | 34 | Jhulisole | 27.3 | 5.81 | 0.585 | Sandy-Loam | 27.36 | 96 |
| 2 | 44 | Neturpur | 27.69 | 5.15 | 0.487 | Sandy-Loam | 28.57 | 105 |
| 3 | 117 | Barabirbhanpur | 29.38 | 6.05 | 0.702 | Silt-Loam | 28.48 | 97 |
| 4 | 118 | Chotobirbhanpur | 29.77 | 4.78 | 0.702 | Sandy-Loam | 28.79 | 100 |
| 5 | 125 | Saldhara | 30.21 | 5.54 | 0.429 | Sandy-Loam | 30.12 | 97 |
| 6 | 121 | Khamani | 30.77 | 7.82 | 0.268 | Silt-Loam | 29.56 | 110 |
| 7 | 128 | Goalbari | 30.82 | 5.75 | 0.643 | Clay-Loam | 29.54 | 122 |
| 8 | 177 | Chhotajambedia | 30.94 | 5.75 | 0.643 | Clay-Loam | 29.95 | 125 |
| 9 | 198 | Sitalpur | 30.97 | 6.01 | 0.507 | Loam | 30.11 | 102 |
| 10 | 196 | ChhotoAmjhor | 31.3 | 5.55 | 0.487 | Loam | 30.65 | 114 |
| 11 | 214 | Damnisol | 31.58 | 5.35 | 0.507 | Silt-Loam | 30.65 | 123 |
| 12 | 217 | Karbanga | 32.29 | 4.8 | 0.351 | Sandy-Loam | 31.95 | 110 |
| 13 | 212 | Gobindapur | 32.95 | 6.37 | 0.392 | Sandy-Loam | 32.86 | 142 |
| 14 | 211 | Kuldiha | 33.89 | 5.23 | 0.487 | Sandy-Loam | 33.59 | 145 |
| 15 | 197 | Kuchalaghati | 33.92 | 5.21 | 0.897 | Loam | 34.56 | 160 |
| 16 | 215 | Kayma | 35.12 | 5.18 | 0.042 | Sandy-Loam | 35.12 | 152 |
| 17 | 207 | Harinarayanpur | 37.05 | 5.91 | 0.391 | Loam | 35.96 | 157 |

**Note: Extracted from Different Fertilizers Pure K is Calculated and Tabulated.**

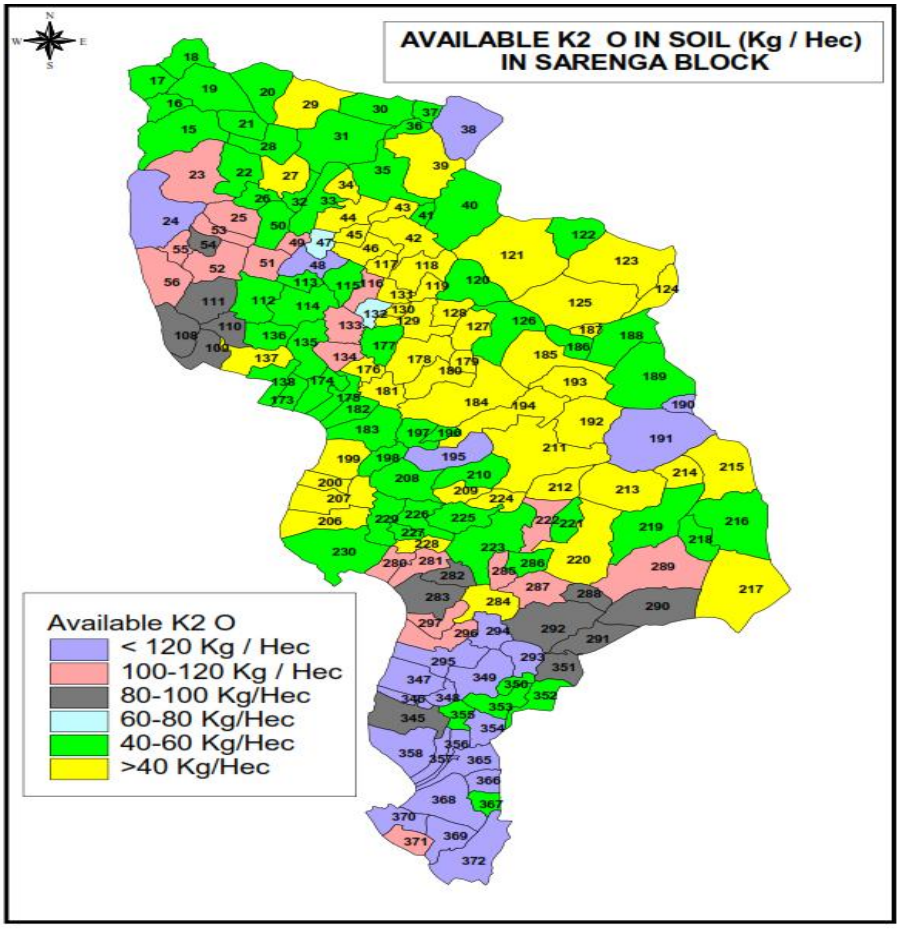
**Source: Tested Results in P.R.M.S. Mahavidyalaya Laboratory.**

**Table- 3**
**Ten (10%) Percent Soil Samples are Chosen where Availability of $K_2O$ is Low with other Characteristics of the Samples Year-2014**

| Sl | J.L No. | Mouzas | $K_2O$ Kg. /Hec | pH | % of O.C | Texture | K Fertilizer Used in Amon Paddy. Kg./Hec | Cropping Intensity (C.I) |
|---|---|---|---|---|---|---|---|---|
| 1 | 24 | Guniada | 126.04 | 5.41 | 0.78 | Silt-Loam | 39.03 | 289 |
| 2 | 51 | Khalaimura | 109.85 | 5.52 | 0.585 | Silt-Loam | 31.97 | 268 |
| 3 | 116 | Baliakhala | 149.45 | 5.57 | 0.585 | Clay-Loam | 40.25 | 288 |
| 4 | 153 | Nibra | 134.19 | 6.18 | 0.585 | Silt-Loam | 37.96 | 288 |
| 5 | 182 | Ghungia | 99.35 | 5 | 0.624 | Clay-Loam | 35.7 | 264 |
| 6 | 283 | Bikrampur | 69.97 | 5.55 | 0.624 | Clay-Loam | 29.55 | 252 |
| 7 | 288 | Chhotogarra | 94.66 | 7.08 | 0.507 | Loam | 31.29 | 258 |
| 8 | 289 | Baragarra | 110.03 | 5.8 | 0.877 | Clay-Loam | 32.92 | 270 |
| 9 | 289 | Baragarra | 110.03 | 5.8 | 0.877 | Clay-Loam | 32.96 | 267 |
| 10 | 295 | Jamirapara | 157.6 | 5.35 | 0.819 | Sandy-Loam | 45.96 | 294 |
| 11 | 296 | Debagram | 112.26 | 5.15 | 0.585 | Loam | 32.96 | 274 |
| 12 | 297 | Choutar | 110.59 | 5 | 0.975 | Clay-Loam | 32.11 | 276 |
| 13 | 347 | Rasunia | 130.13 | 4.5 | 0.507 | Sandy-Loam | 39.14 | 292 |
| 14 | 354 | Indaberia | 154.2 | 5.56 | 0.585 | Sandy-Loam | 45.22 | 292 |
| 15 | 356 | Janapara | 111.29 | 5.55 | 0.604 | Silt-Loam | 32.95 | 275 |
| 16 | 358 | Bamundiha | 158.6 | 5.14 | 0.682 | Sandy-Loam | 46.11 | 294 |
| 17 | 371 | Thakurbari | 107.11 | 4.88 | 0.429 | Sandy-Loam | 31.62 | 299 |

**Note: Extracted from Different Fertilizers Pure K is Calculated and Tabulated.**
**Source: Tested Results in P.R.M.S.Mahavidyalaya Laboratory.**

**Map No. - 2**



**Conclusion**

An interesting picture is observed from the analysis of availability of $K_2O$ in soil and others so called controlling factors. Soil pH and percentage of organic carbon have a feeble relationship with the availability of $K_2O$. Soil pH is slight negatively related with the availability of $K_2O$. But theoretically we know that the pH 6 to 7 is ideal for Potassium availability. pH of the soil in the study region is mainly acidic. This acidic soil may negatively affect the availability of primary $K$+ ions. But in the study region only 24.7% mouzas has the said pH value. Observation shows that in many mouzas has low pH with high $K$ availability.

$K$ fertilizer has the dominant role for the distribution of available $K_2O$ in the agro-fields throughout the study region. Soil characteristics are continuously changing through the application of chemical fertilizer including $K$. Increase of soil acidity is the most common example in this regard. Results also prove it. A good positive correlation is found in every case between availability of $K_2O$ and cropping intensity of the fields. Input of fertilizer is high in the high cropping intensity areas than low cropping intensity areas. In field study we have identified this fact. For example, in northern part of the Sarenga Block the amount of available $K_2O$ is ranging from 28.48 Kg./Hec. to 46.84 Kg./Hec. associated with very low (91 to 96) cropping intensity. On the otherhand, it is observed, in south-eastern part of the study region high availability of $K_2O$ associated with high cropping intensity (176 to 298). In this area $K_2O$ ranges from 77.76 Kg./Hec to 158.6 Kg./Hec. Soil texture is also incorporated in the table No.-2 and 3 but it is not a numeric value. So calculation of correlation is not possible from this data. From the observation it is cleared that there is no any specific relationship with $K_2O$. So after analysing all the factors we can say availability of $K_2O$ in agricultural soil of Sarenga Block is very much related with $K$ fertilizer usage rather than any other controlling factors. But it should be kept in mind that every component of the soil is so interlinked that modification of one component affects other. So selection of controlling factors is not free from controversy. But with the help of these factors a broad generalization is possible.

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