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Juxtaposition of Push-Type Wheel Hoe to Evaluate Its Weeding Coherence and Impair on Eggplant

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Abstract: A study was done to access the best suited mechanical weed control method in eggplant crop as use of mechanical methods in eggplant crop will enhance the crop growth and reduce the use of herbicides and chemicals that affect the soil properties of crop. The weeding efficiency of the wheel hoe$_1$ and wheel hoe$_2$ was calculated at different levels of forward speed and depth of weeding in Allahabad region in eggplant crop at 21st, 40th and 75th day after sowing. The plant damage was recorded at the fifth day after the weeding operation was performed in the field. The plant damage increased as the speed of operation increased but the depth of operation had no significant effect on the plant damage. Plant damage was dependent upon the skill of the operator and environmental factors like sunshine, wind etc.
Key words: wheel hoe, eggplant, forward speed, weeding efficiency.

I. INTRODUCTION

Mechanical weeding is the most important method for controlling weeds since it is economical keeps the soil surface loose, which is good for root aeration in eggplant plant and so will increase the water intake capacity. Mechanical control of weeds is very effective and the result is immediately observed. Mechanical control of weeds involves use of weeders operated by human labor, animal or tractor. Out of these, manual weeding is most effective but it consumes too much human power and is very slow process. Manual control is the use of the hands or handheld tools to deal with weeds. Extensive amount of cheap manual labor is cheap In developed countries like, USA, European Union Countries, Australia and Israel large emphasis has been placed on mechanization of the various agricultural processes. For this number of machines have been developed and successfully implemented. **Rangasamy et.al (1993)** evaluated the performance of a power weeder and compared with conventional method of manual weeding with hoe and manually operated dry land weeder.

The power weeder was operated by 1.7 hp RT 35 engine. The field capacity of the weeder was 0.04 ha/h with weeding efficiency of 93% and performance index of 453. The cost of operation of power weeder amount to be Rs. 250 against Rs. 490 by dry land weeders and Rs. 720 by manual weeding with hoe. Saving in time is 93%, saving in cost is 65%.Use of such machines in the Indian Agricultural Scenario is difficult as most the Indian farmers are small scale farmers as area under their control is small. Mechanical weeders range from basic hand tools to sophisticated tractor driven or self-propelled devices. These may include cultivating tools such as hoes, harrows, tines and brush weeders, cutting tools like mowers, as well as implements like thistle-bars that may do both. Two wheeled pedestrian or walking tractors are a smaller alternative that can power a similar range of implements. The weed infestation is the basic problem that comes during different stages of plant growth. **Biswas (1999)** conducted their studies on development of animal drawn weeder in India.

He found that improved animal drawn weeders play an important role in mechanical control of weeds. Due to high output animal drawn weeders help in timeliness operation compared to manual method and therefore it is economical to use them. Transfer of available technology to farmers can reduce the loss of yield due to weeds and increase the agricultural production. Hence, the study was done to access the best suited mechanical weed control method in eggplant crop. As stated, the operations performed in the field after sowing but before harvesting the crop are called as intercultural operations. It includes breaking the upper surface of soil, uprooting the weeds (unwanted plants), aerating the soil, thereby promoting the activities of microorganism and making good mulch, so that moisture inside the field is properly retained from evaporation. These operations are accomplished by means of many tools and equipments, such as hoes, cultivators, harrows, rotary hoes, weeders etc.

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II. MATERIALS AND METHODS

The field experiment was carried out in Mahewa block of Allahabad and in village Kukhudi of Kundiyara block in Tehsil of Karchna of Allahabad in the month of February to May in the year 2015 to evaluate the weeding performance of the different mechanical weeders and to test the ergonomic effect of the weeders on the operators.

A. Selection and Description of Different Weeders

1) Long Handle Weeders

Hand hoes exert greater strain on the operator because of the short handle with necessitates the operator to do weeding job in bent posture. To avoid this nowadays long handles are used in hoes and hence they are called as long handle weeders. The popular long handle weeders available are a) star type weeder b) peg type weeder. These weeders are also called as dry land weeders since they are used in dry lands. The wheel hoe is a widely accepted weeding tool for weeding and intercultural in row crops. It is a long handled tool operated by pushes and pull action. The general construction of wheel hoe comprises of a wheel, tool frame, a set of replaceable tools and a handle Different types of soil working tools such as straight blade, V -blade, sweep, shovel, etc. can be used for different works namely weeding , soil mulching, stirring etc. .Long handle reduces drudgery to operator. Wheel reduces energy requirement for pushing. All the soil working components of the tool are made from medium carbon steel. The coverage is 0.05 ha/day

Figure 3.1. Three tyne cycle type hand hoe.

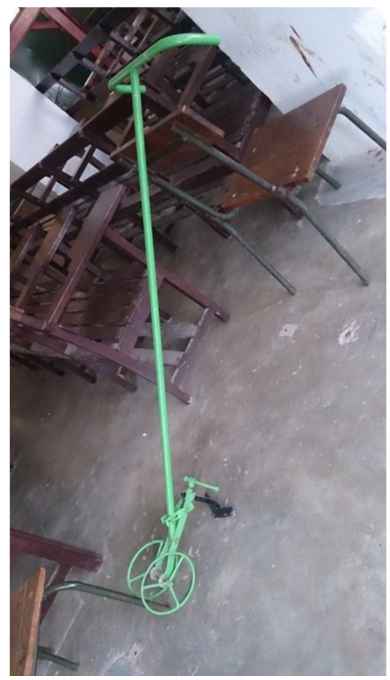

Figure 3.2. Single tyne cycle type hand hoe.

TABLE. 3.1 SPECIFICATIONS OF WHEEL HOE

PARAMETERS	Wheel hoe$_1$	Wheel hoe$_2$
Type	Push type wheel hoe (1 tyne)	Push type wheel hoe (3 tyne)
Type of tyne	Sweep type	Sweep type
Number of tynes	1	3
Overall dimensions, cm	170*8*110	150*30*110
Length	170	150
Width	8	30
Hieght	110	110
Wieght ,kg	60	65

Diameter of wheel, cm	8	24
Hieght of handle from ground ,cm	0.50	0.42
Working width ,cm	0.08	12
Depth of operation,cm	0.6	0.9
Hieght of spike/ tyne,cm	15	12
Number of spike/ tyne	1	3
Arrangement of spike/tyne	Hanged and bolted	Hanged and bolted
Range of adjustment for width and depth	15-18	20-24
Type of handle	Push type	Push type
Number of operator needed	1	1

2) Preparation Of Weeder For Field Test And Preparation Of Land

The fasteners were checked for working condition and all the parts were lubricated. The weeder was operated for some time to be acquainted with the handling of the weeder under field conditions.

a) Selection Of The Test Plot

- *Size of the plot: For* the uniform working, the minimum size of the field was fixed as 10 * 10 meters.
- *Type of soil:* The weeders were tested in the field to eliminate the variations in test results due to soil factors. The mechanical analysis of the soil in the test plot was done to determine the type of soil. The test conducted for mechanical analysis for determination of the type of soil were as follows :

b) Soil Moisture Content (MC_{soil})

- *Weed population:* As it is difficult to control the population of weeds, so the average number per square meter was recorded. One meter square frame was used for measuring weed population. The counts from five random places were taken and the average number was determined.
- *Size of weed:* An important factor influencing the performance of weeder is the size of different weeds. The size was determined by counting weeds per kilograms of mass of each type. The average of five at random counts may be taken as representative of the field was taken into records.
- *Stage of maturity:* The stage of maturity of the crop readily affects the use of weeder on the field. Therefore, the weeding of the field was done on the twentieth, thirtieth or fortieth day after sowing.
- *Row spacing of the Crop*: 20 cm for wheel hoes, 40-50 cm for tractor operated weeders and 70 cm for power operated weeders.

➢ *Weeding Efficiency:* The average number of weeds present per square meter area before weeding should be determined. In the similar manner, the number of weeds left out per square meter can be counted 5 days after the weeding test is completed. The difference of the two will give the num.ber of weeds eliminated and the efficiency of weeder can be computed as follows:

$$\text{Weeding Efficiency} = \frac{\text{number of weeds eliminated per metre square}}{\text{total number of weeds present per meter square}} X\ 100$$

Weeding Efficiency, (e) = $(W_1 - W_2) \times 100/W_1$

Where,
W_1= number of weeds before weeding in the unit area of actual weeding.
W_2= number of weeds after weeding in the same area.

➢ *Plant Damage:* Plant damage is the ratio of the number of plant damaged by a weeder to the number of plants present initially in a unit area. It is expressed as percentage

Plant damage (P_d) = $N_2 x100/N_1$

Where,
N_1 = the number of plants initially present, and
N_2 = the number of plants damaged.

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Evaluation of manually operated push type weeder (wheel hoe) was carried out in the field of Department of Farm Machinery and Power Engineering, S.H.I.A.T.S, Allahabad. Field experiments were conducted for different combination of three subjects with four forward speeds and different depth of operations.

TABLE. 3.2 TEST CONDITIONS FOR WHEEL HOE

Condition of field and soil	21st DAS ,D_1	40th DAS, D_2	75th DAS , D3
1. Location of field	District –Allahabad, block – Mahewa.		
2. Kind of field	Upland		
3. Width of field	7 meter		
4. Area of field	21 meter		
5. Shape of the field	Rectangular		
6. Type of the soil	sandy- loam		
7. Soil moisture content	47.428 (due to 3mm precipitation)	51.14%	19.43%
Condition of the weeds			
1. Name of the infested weed	Hirankhuri	Hirankhuri	Hirankhuri and doobh
2. Average weed population	269 cm	367cm	1466cm
3. Average height of the weed	4.89cm	7.87cm	15.2cm
Condition of crop			
1. Name of the crop	Eggplant		
2. Variety of the crop	Purple		
3. Planting method	Hand transplantation		
4. Date of sowing	8/2/2015		
5. Age after sowing	21DAS		
6. Average crop height	7.66cm	37.7cm	58cm
7. Average row spacing	64.4cm		
8. Average crop plant population	6 plant per meter square		
Ambient conditions			
1. Temperature	31	33	38
2. Relative humidity	28%	26%	24
3. Wind velocity	12km/h		8km/h
4. Wind direction	South to east	South to east	South to west
5. Rainfall	3mm	nil	nil
6. sunshine	11h 29min	11 h 34 min	12h 58min

III. RESULTS AND DISCUSSION

For the testing of the mechanical weeders first the specification of the different weeders were recorded. Then the field tests were performed to calculate and compare the performance of the different weeders in the field. The weeders were tested in the three plots of 10*10 m^2 fields and the testing was done on the 21st, 40th and 75th day after transplanting the plants in the field. The type of soil was tested in the laboratory. The mechanical analysis of soil was done and soil moisture content of the selected plots was determined each time before testing the weeders in the field.

A. Performance Evaluation of push-type Weeder

The push type weeders were tested in field of in block Mahewa of district Allahabad. The test plot was of size 3*10 m^2. The average soil moisture content (MC_{soil}) was 47.428 %, 51.142% and 19.428 % for 21st, 40th and 75th DAS, respectively .The other field conditions and data for wheel hoe are given in appendix –B. During the operation, the weeding efficiency was calculated at different forward speed of operation. The machine was run at four forward speeds of 1.2 km/h, 2.4 km/h, 3.6 km/h, and 4.8 km/h. The weeding was done at four different depths of 35mm, 50mm, 65mm and 80 mm. The machine was allowed to operate at the four different speeds and at specified depth, weeding was performed. Three replications were done to eliminate the errors.

1) Case 1: Wheel hoe $_1$

When wheel hoe $_1$ was operated at the different speed and different depth, On the 21st DAS the weeding efficiency increased from 49.231% to 56.526% at different speed, but it was observed that when the speed of operation was 2.4 km/h and the depth of operation was 50mm the weeding efficiency was most that is 56.526 % .It was seen that there was no significant increase in the weeding efficiency when the speed was increased. At the forward speed of 4.8km/h and depth of 80cm, the weeding efficiency was found to be lowest at 49.231%. Instead, plant damage percentage increased on the increase of speed from 16.299% to 29.557 %. It was found that at the forward speed of 2.4km/h and depth of 50mm the plant damage percent increased to 29.557%. The plant damage was observed after 5 days of weeding operation. The dried plants are also considered as damaged crops. At the 2nd day of weeding, that was 40th DAS.

The weeding efficiency increased from 47.894 % to 56.151% .It was seen that at the forward speed of 3.6 km/h and depth of 65mm the weeding efficiency was 56.151% but as forward speed was further increased to 4.8 km/h and the depth of operation augmented to 80mm the weeding efficiency decreased to 47.894 % other than that for the plant damage percentage , the same speed of operation that is 3.6km/h and 4.8km/h and depth of 65mm and 80mm showed that maximum plant damage percent of 27.5% and 10.897% ,respectively.

On the third day of weeding, this was 75 DAS of the plantation of crop. The weed population had increased and it was found by the recorded data that the weeding efficiency ranged from 44.447% to 55.268%. A little contradiction was observed that at the forward speed of 2.4 km/h and depth of 50mm the weeding efficiency was high i.e. 55.268% and like observed previously, the weeding efficiency was lowest at forward speed of 4.8km/h and depth of 80mm. Weeding efficiency was 44.447% . whereas when the plant damage percent was observed 29.487% at 4.8km/h of forward speed and depth of 80mm which was highest and the lowest plant damage was observed to be 19.482% at a forward speed of 1.2km/h and depth of 35mm.From this observation it was clear about the wheel hoe$_1$ that if the forward speed ranged between 2.4km/h and 3.6km/hr and the depth was between 35mm to 65mm the weeding efficiency was high in comparison to the high forward speed of 4.8km/h and depth of 80mm.

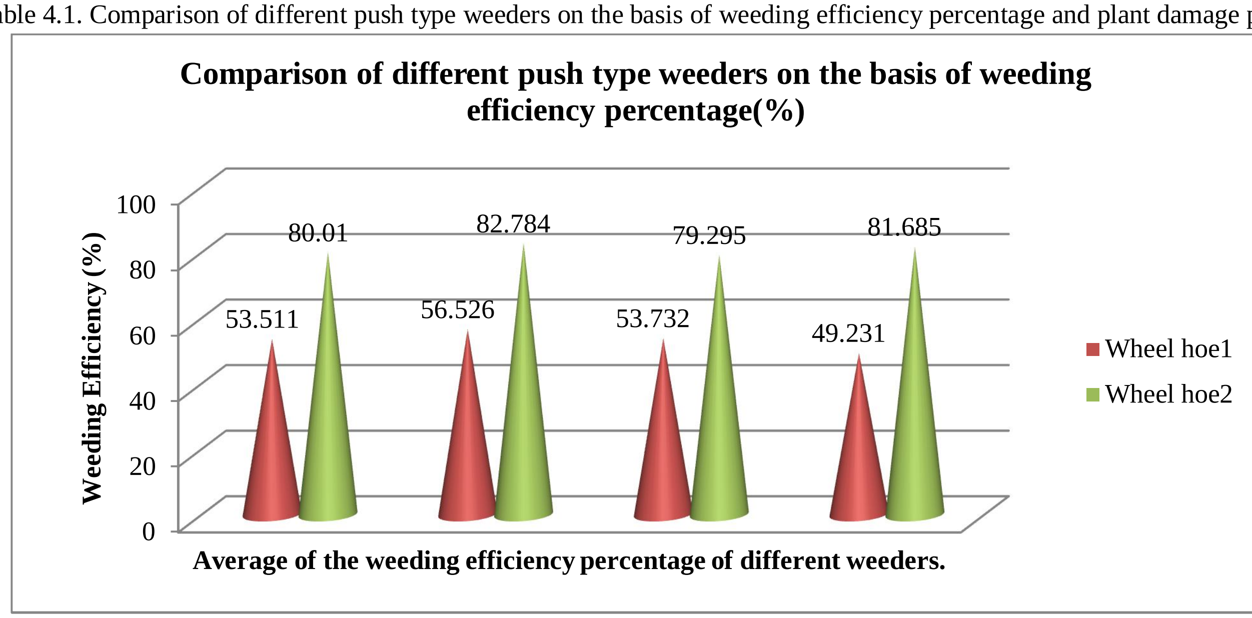
Figure 4.1 field evaluation of Three tyne wheel hoe and plant damage observed after 5th day of weeding.

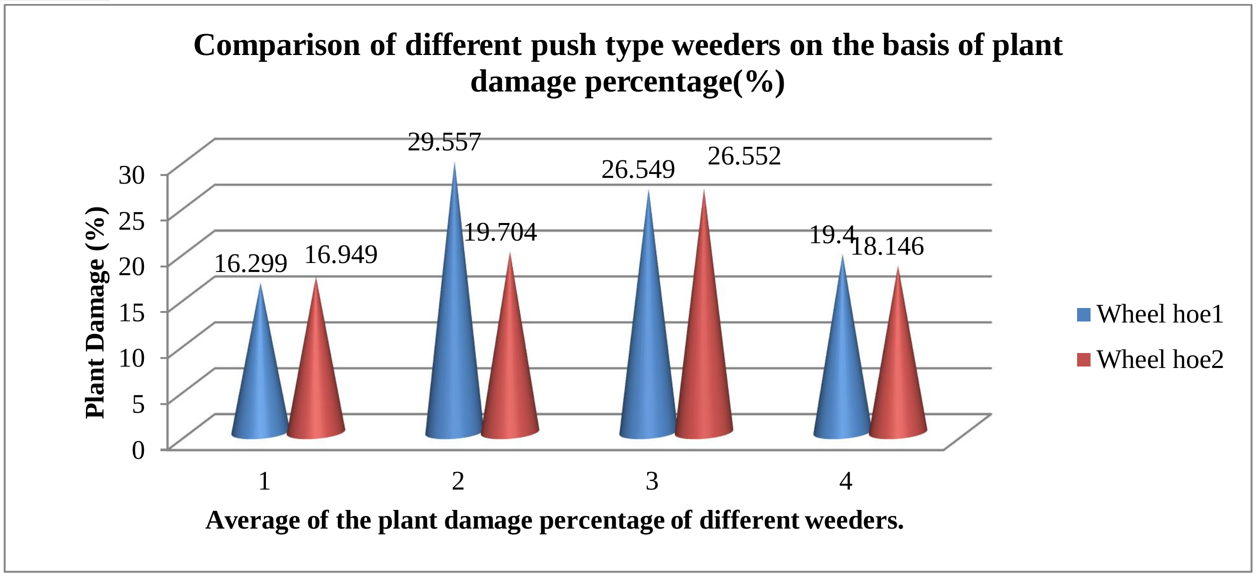
2) Case 2: Wheel hoe $_2$

As wheel hoe$_2$ was operated in the field with different level of speed and at different depth, the first day of operation showed that at the speed of 2.4km/h and depth of 50mm weeding efficiency was at its peak i.e. 74.836 % but when the speed was increased there was a gradual decrease found in the weeding efficiency .It was found that weeding efficiency was 69.904% at 3.6km/h and 65mm which was lowest for the 21st DAS .The range of weeding efficiency was 69.904% to 74.836 % at different speed of operation and depth of operation. It was observed that at speed of 1.2km/h and depth of 35mm the plant damage was least 12.500% but at speed of 3.6km/h and depth of 65mm plant damage was 31.250%. On the 40th DAS , when the weeding efficiency was 84.894% on the operating speed of 3.6km/h and depth of 65cm whereas the weeding efficiency declined to 81.708% at 4.8km/h of speed and 80mm depth .the weeding efficiency varies from 81.708% to 84.894 % at various speed and depth respectively. The plant damage observed was 16.190 at low speed of 1.2km/h and depth of 35mm but was highest at speed of 3.6km/h and depth 65mm i.e. 29.006% .At the 75th DAS of eggplant plantation, the weed population was at hike. The weeding efficiency had a variation between 83.871% and 90.964%. It was noticed that the lowest weeding efficiency was 83.871% at the operating speed of 1.2km/h and depth of 35mm but when there was a steady increase in speed, at 4.8km/h and 80mm depth the weeding efficiency was highest 90.964% and the plant damage was 13.461% at the same speed and depth but was 22.160% at low speed of 1.2km/h and depth 35mm which was highest as per the data observed. The main reason for this variation observed was that with the increase of speed and depth, the deep rooted weeds were easily uprooted hence weeding efficiency was highest at high speed and depth.

Figure 4.2 field evaluation of wheel hoe$_2$ and plant damage observed after 5 days of weeding.

Table 4.1. Comparison of different push type weeders on the basis of weeding efficiency percentage and plant damage percentage





IV. SUMMARY AND CONCLUSION

The weeding efficiency of the wheel hoe$_1$ and wheel hoe$_2$ was calculated at different levels of forward speed and depth of weeding in Allahabad region in eggplant crop at 21st, 40th and 75th day after sowing. The plant damage was recorded at the fifth day after the weeding operation was performed in the field. The operation of wheel hoe$_2$ at the same speed and depth depicted weeding efficiency of 82.74% but wheel hoe$_1$ was only 49.23 % at the highest permissible speed which showed wheel hoe$_2$ was much better to work with as compared to the other. Also the plant damage was found approximately in similar pattern as in comparison at lowest and speed but was 29.55% at 2.4 Kmps in wheel hoe$_1$ but in wheel hoe$_2$ it was 19.70 at same speed. Hence, as per the study done, Wheel hoe$_2$ was proven much better to work with on small plots.

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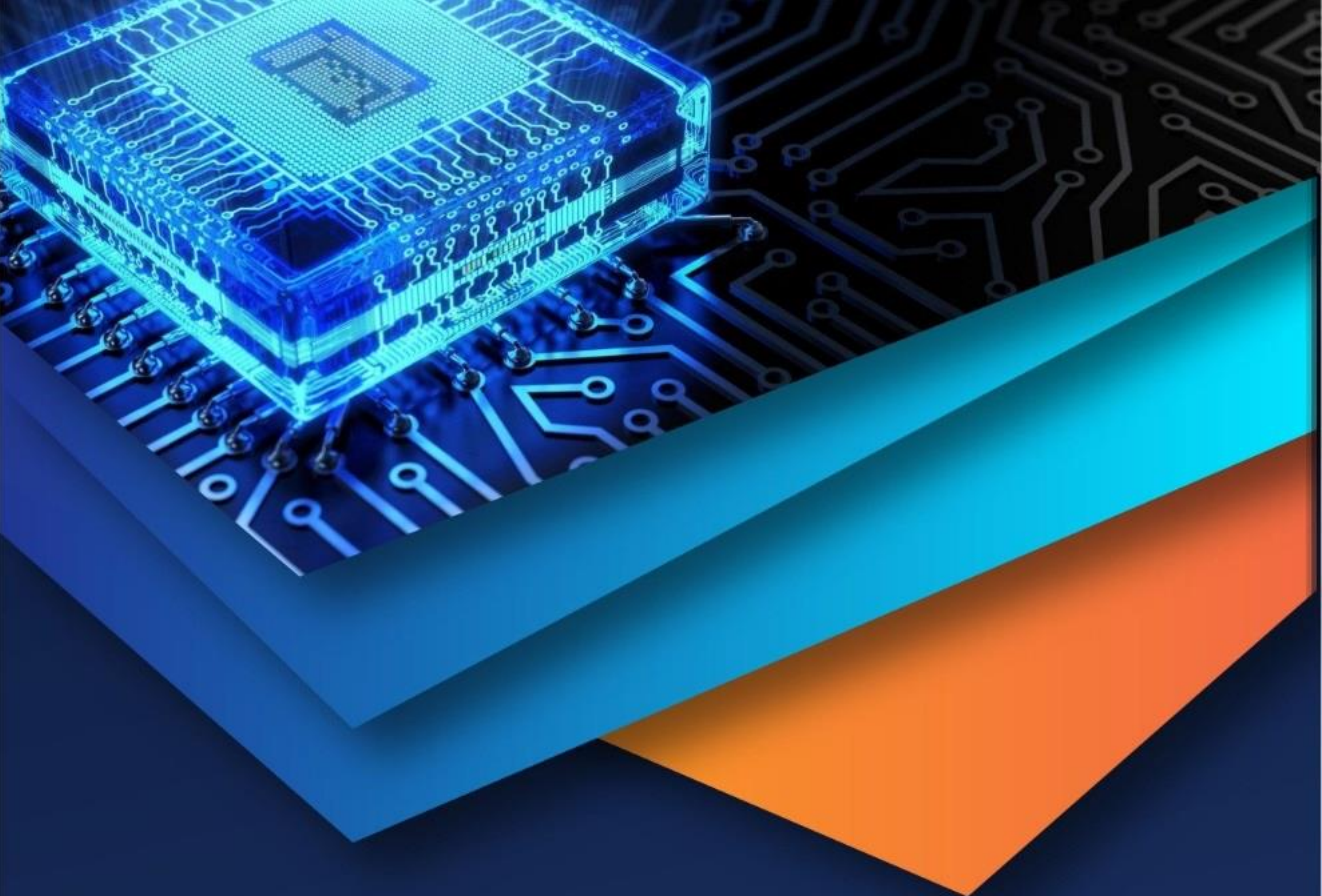

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